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TECHNOGRAPH

Illinois U. Libra

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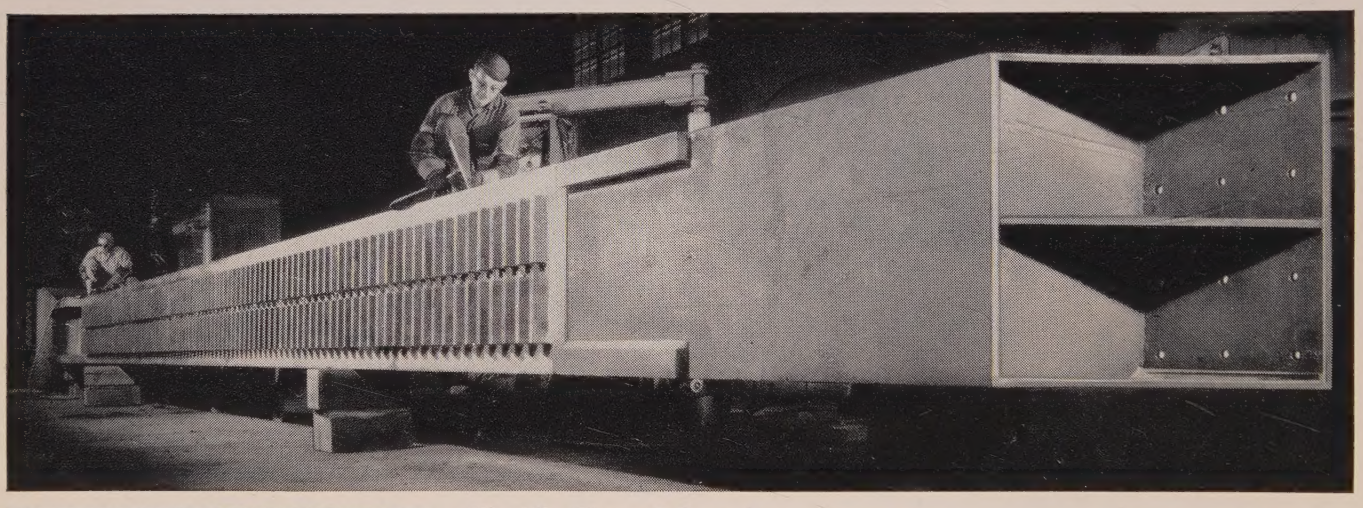
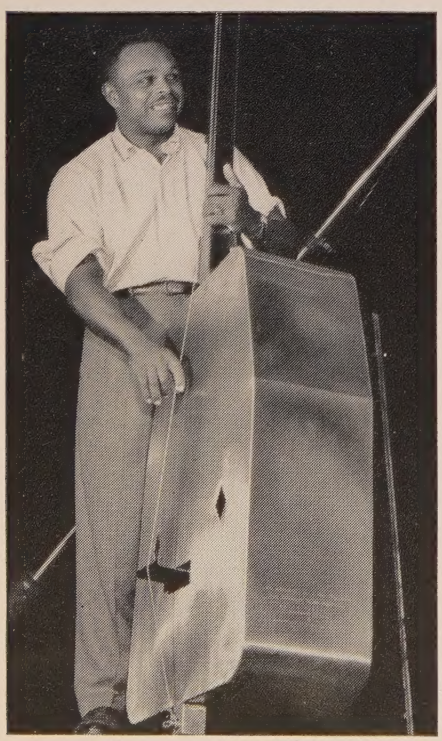
Only STEEL can do so many jobs so well

Steelaire Home. The entire structural frame of this house is made from tough, cold-formed steel, so it is unaffected by rot, fungus, and termites. Even more important is the fact that the steel frame resists warping and sagging. It's one of a line of *Steelaire* homes and is made by the U. S. Steel Homes Division of United States Steel.





World's Biggest Crowd. On power shovels, a "crowd" is the arm which moves the dipper and dipper-stick forward and back. It coordinates closely with the lift motion of the dipper, and is a key part in the operation of the shovel which must withstand extremes of stress at any temperature. This is a picture of the biggest crowd ever built, now installed on the biggest power shovel in the world. It's made from USS "T-1" Steel, the remarkable new constructional alloy steel developed by United States Steel. An exceptionally strong and tough steel, it is noted for its welding characteristics. *"USS" and "T-1" are registered trademarks.*

Slap That Bermudavarius! The Talbot Brothers of Bermuda, famous for their colorful calypso music, recently retired their homemade packing-case "bass viol," and proudly premiered in its place the world's first Stainless Steel bass viol (or dog house or Bermudavarius, as it's customarily referred to). An exact replica in USS Stainless Steel of their original homemade design, it was built for them under U. S. Steel's supervision by a well-known manufacturer of Stainless Steel sinks who commented that the fabricating job wasn't difficult—but certainly was *different.*

UNITED STATES STEEL

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CONSOLIDATED WESTERN STEEL . . . GERRARD STEEL STRAPPING . . . NATIONAL TUBE . . . OIL WELL SUPPLY
TENNESSEE COAL & IRON . . . UNITED STATES STEEL HOMES . . . UNITED STATES STEEL PRODUCTS
UNITED STATES STEEL SUPPLY . . . ***Divisions of*** **UNITED STATES STEEL CORPORATION, PITTSBURGH**
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Watch the **United States Steel Hour** on TV every other Wednesday (10 p.m. Eastern time).

7-2467

1127

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•

Business

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Roger Harrison

•

Circulation

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•

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THE ILLINOIS TECHNOGRAPH

Volume 73 **Number 1**

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Cover . . .

This month's cover represents the conspicuous new addition to North Campus: the antenna on the E. E. Building. The art work is by James Koertge, undergrad student majoring in art here at the University, and is the first of a series under our new format.

Hundreds do it every day, without ever leaving the company. Confined by an unimaginative management, they sink to the level of pencil pushers . . . or slip-stick artists, losing the value of their intensive academic training. But the youthful engineer does not have to suffer this fate. Selecting the right company . . . with thought to its reputation for leadership, initiative, and atmosphere . . . makes the difference.

Linde Company is world renowned for its progressive development in many fields . . . in atmospheric gases and acetylene, welding and flame processes and equipment, synthetic crystals and adsorbents to name a few. This leadership has only been won through the creative powers and initiative of LINDE engineers and scientists. And, these men have received individual recognition of their achievements.

You can find out more about career opportunities at LINDE, in research, development, production, sales, and staff positions, from your Placement Officer. A booklet, "Look to LINDE for your future," is available by addressing Mr. P. I. Emch, Central Recruiting Office, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

A LEADER FOR 50 YEARS

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UNION CARBIDE

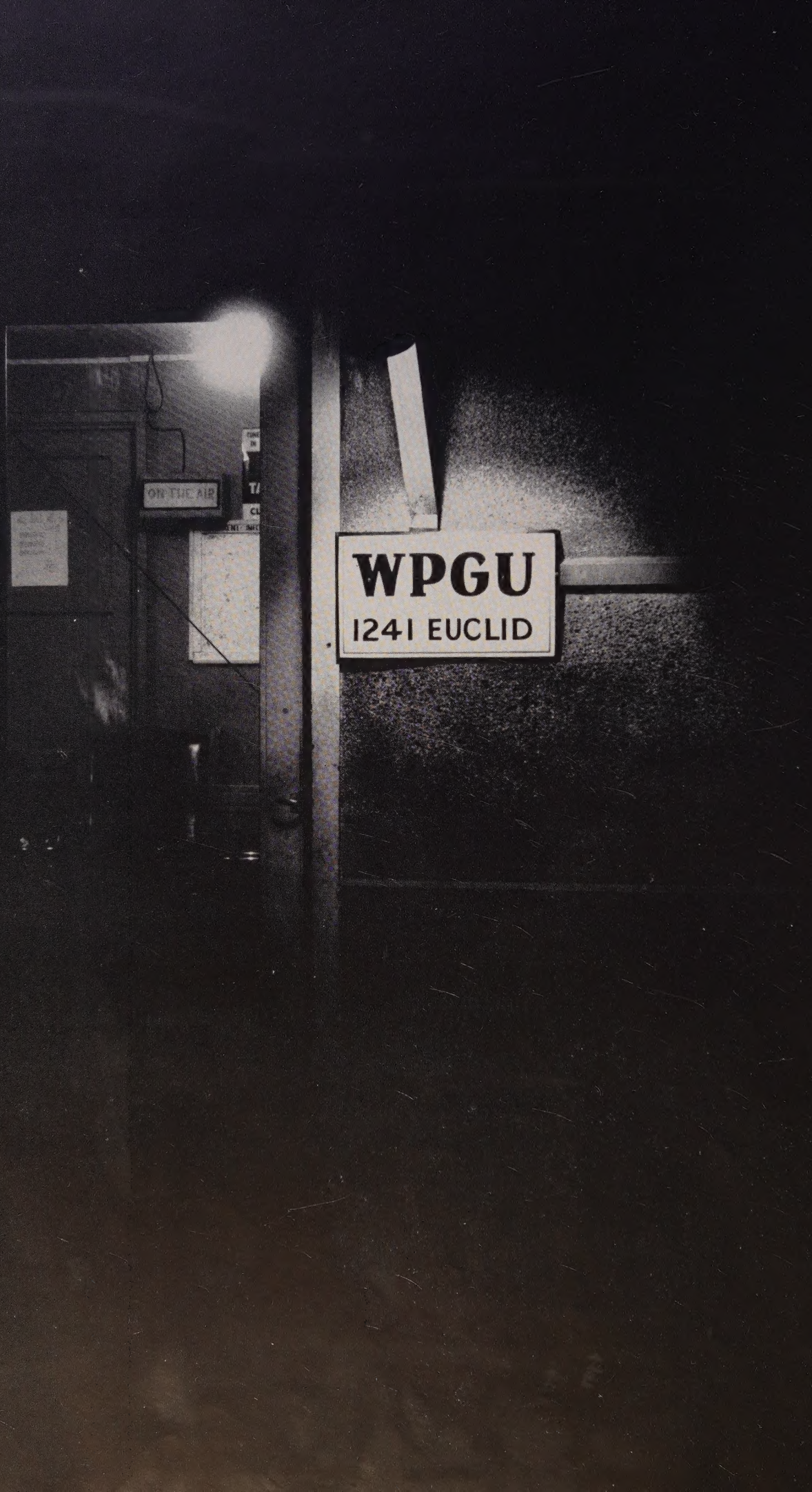
LOOK US OVER

Yes, what you're looking at is the first copy of the NEW Technograph. This issue and the ones to follow in the remainder of this school year have been redesigned to bring you more of the features YOU want to see.

Each year the Tech seeks to bring to its audience just the proper balance of features to please the majority of its readers. We believe we have come very close towards that goal. The primary changes include more local features, more features with "time value," more coverage of engineering societies, more "Who's Who," more photos, more illustrations, and more Technocuties. In order to attain these goals, we have had to sacrifice some of the rather technical aspects of the magazine, although some still have been retained. We have also increased our personnel advertising coverage, enabling you to know more engineering companies.

We of the Tech hope we are succeeding in bringing you the magazine you want. Why not let us know? But first . . . LOOK US OVER.

—JTK


ON THE AIR
WPGU
1241 EUCLID

WPGU

by

Dave Yates, E.E. '60

Roger Harrison, E.E. '59

Jim Kries, E.E. '59

"You're in tune with WPGU, student radio on the campus in Champaign-Urbana. The time is————."

This message is beamed daily to an audience of approximately 5,000 students here on campus and is the station break for one of the fastest-growing activities on campus. Broadcasting on frequencies of 640 and 610 kilocycles, WPGU holds the distinction of being on the air longer than any other station in the Champaign-Urbana area (almost 140 hours per week).

Main studios of the station are located in one of the PGU buildings at 1241 S. Euclid Ave., Champaign, directly behind Clark House, MRH. The actual transmitters are in several locations around the campus area, connected to the studios by telephone lines. Although most of the programming comes from the main studios, WPGU leaves its studios for special events programming, such as their "Twenty Questions on the Campus" show every Saturday evening, Club Sophisticate at the Illini Union, Engineering Open House, and many others.

To keep this busy station on the air requires the services of many people: announcers, engineers, salesmen, copy

BIG PLANS are in the making as the "wheels" consider the impending relocation of the station next year. Reading clockwise are: Art Anderson, Chief Engineer; George Dixon, Engineering; Chuck Leonard, Program Director; Jim Dean, Continuity Supervisor; Cliff Johnson, Former Station Manager; Bill Carmody, Station Manager; Dick Adams, News Director; Esther Ary, Engineering (former Record Librarian); and Phil Lieb, Commercial Manager. In the top photo Chuck Leonard is seen checking the news coming off the UP wire.

ENGINEER Jerry Giambri is seen operating the main control console. Note that the board is arranged for dual channel operation. The tape recorder and turntables are also shown.

writers, secretaries, and many others. In fact, a staff of almost 150 currently works to provide entertainment for its listening audience. To keep activities running efficiently, WPGU is divided into separate departments: program, commercial, engineering, and station manager.

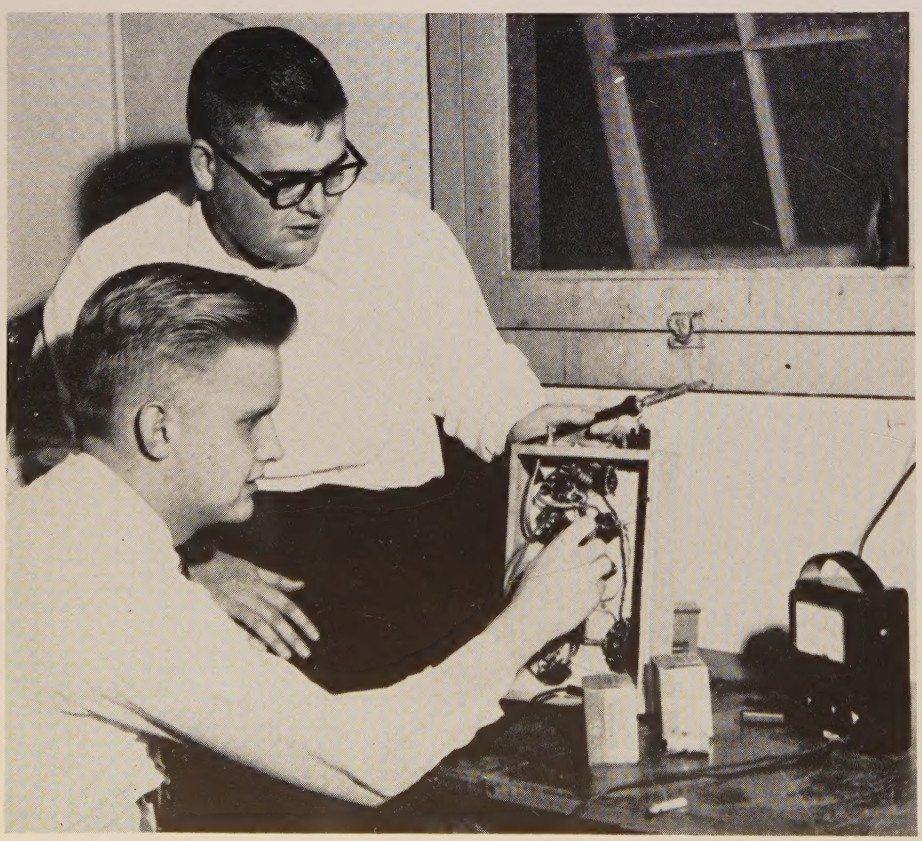
Under the program director are three divisions: announcers, under the Chief Announcer, Chuck Richards; newscasters, under the direction of Dick Adams; and the sports staff, headed by Ron Garber.

Before anyone gets on the air, he (or she) must be approved by the program department through an audition. The prospective announcer or newscaster reads a series of selections and is recorded on a tape recorder. The voice quality and other factors are considered during playback; and, if he is approved, his name is read off a card, and he then is assigned a show and becomes a probationary announcer.

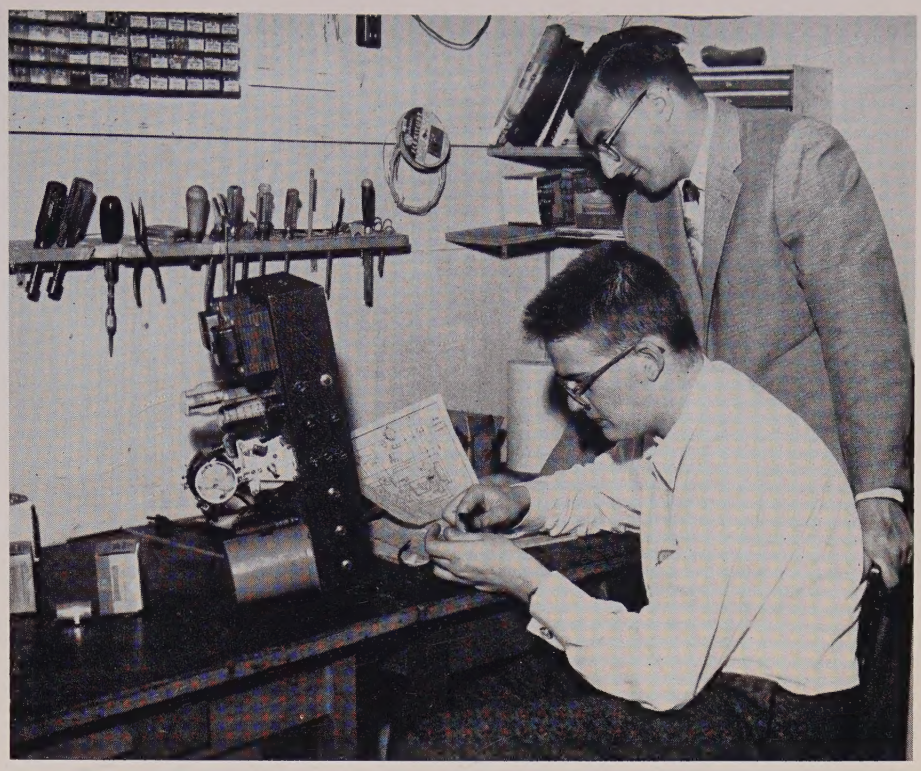
After a couple of months every probationary announcer is reviewed. If he then meets the professional standards of the station, he is promoted to the position of staff announcer and will become eligible for some of the better time spots as they become available. After long and successful service, some staff announcers are promoted to the position of senior announcer, the highest grade. WGPU currently has about a half dozen senior announcers.

These announcers are responsible for the programming heard on the station. Each announcer selects his own show, picking the recordings *he* thinks most appropriate for the time and type of show. An obvious exception is, of course, the request show. These are presented daily to give the listeners their chance to hear their favorites. These requests, along with listings from *Billboard* and "Top Ten on WGN," form the basis for the Top Ten on WPGU program, a regular feature of the station.

Format for the programs is de-



←
UNDER THE careful eye of Ron Hartley, Bert Carlson checks out a newly-completed amplifier chassis.



TRANSMITTERS ARE important items at the station so Art Anderson and George Dixon discuss a technical point about the transmitter shown on the table.

→

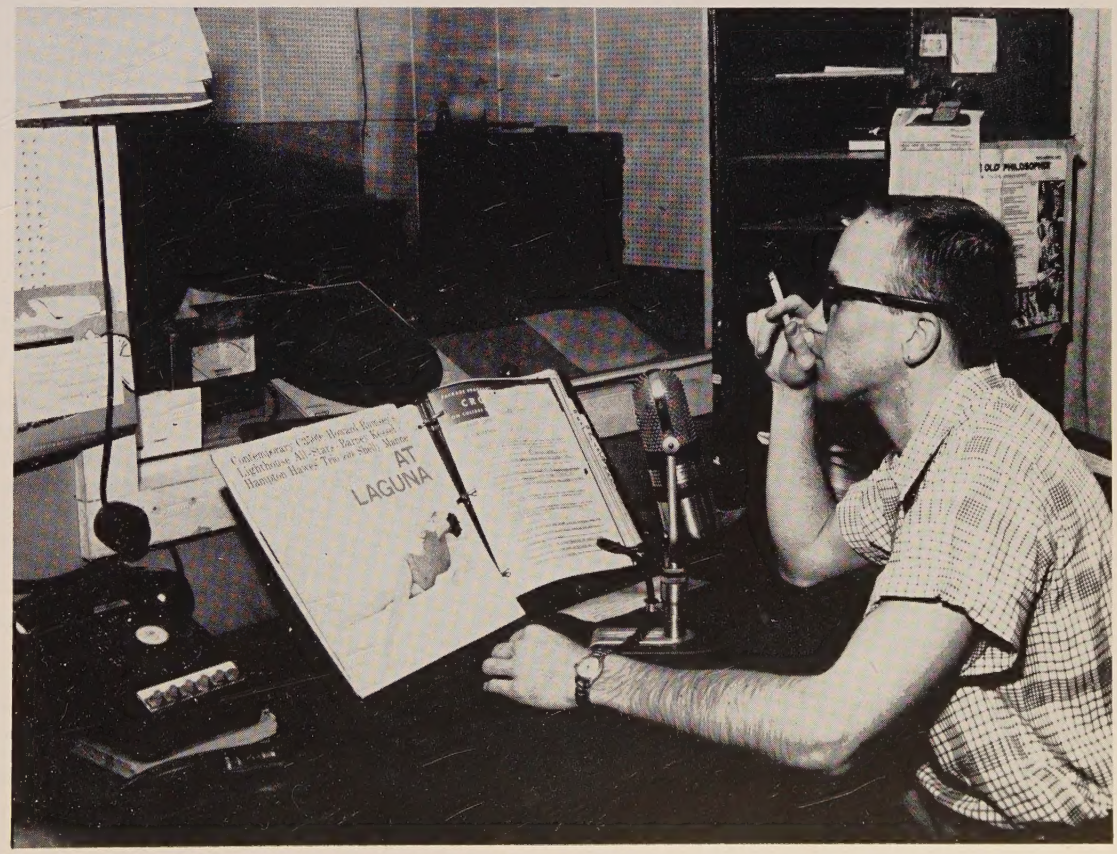
termined by the program department. Each time segment is given a particular type of material or a particular theme. This prevents you the listener from getting eighteen hours of the top ten, Stan Freeburg, and Elvis Presley. The old rule of "Variety is the spice of life" holds at WPGU.

Before any show gets out onto the airways, however, it must be engineered. The engineering department, under the competent leadership of Art Anderson, is in charge of all technical equipment of the station. Through the Engineering Operations Supervisor, all of the necessary studio engineers are procured. Through the activities of other engineers, equipment is maintained and new equipment designed and constructed. Art Anderson has been with the station from the beginning and is responsible for the design and construction of the station's equipment, bringing it from its infancy to its present position of leadership.

As with announcers, the studio engineers who twist the dials and spin the records must go through a training program. Anyone applying for a position as studio engineer goes through a short training course given by the operations supervisor. Upon successful completion of the program, he is promoted to the position of probationary engineer and is assigned to engineer certain shows.

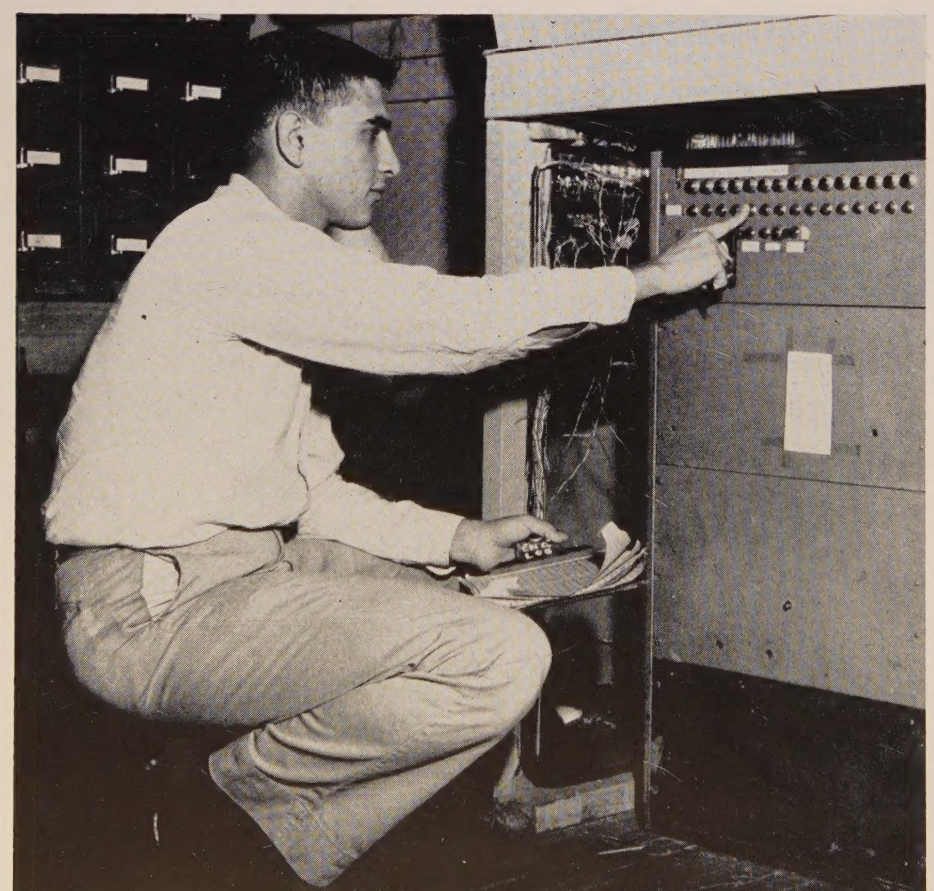
After about two months he is reviewed for possible promotion based on his abilities and interest. Some of the requirements include operation of the tape recorder, segueing (going from one record directly into the next without voice announcements), and procedures to use in case of equipment malfunction. If he passes, he is given the position of studio engineer, capable of handling the regular operations of the station. If his particular shift requires special training, as for a remote show, he is then given more on-the-job training for that particular job.

Because many announcers "combo," all announcers are required to attain the position of studio engineer as well



ANNOUNCER Wally Hoel in Studio A is gazing at the clock, waiting to give record commentary and a few commercials from the book. The control room can be seen in the background through the double glass partition.

NEW RECORDS are always news so Esther Ary tells Chuck Leonard about some new releases. In the lower photo, Jerry Giambri is checking the meters at the transmitter control unit.



as passing their own tests for announcing. "Comboing" is combining engineering and announcing, i.e., the announcer in his own engineer. In this way, the station can continue to operate even if an engineer is not available. (Regular engineers cannot "combo" since no one can appear over the air who has not passed an audition, except for special guests).

Another group within the engineering department are the technicians. Regular transmitter maintenance, both in terms of routine checks and emergency repairs, is handled by this group. Members of this section are on call twenty-four hours a day, ready to tackle any malfunctions which might occur.

Whenever new equipment is constructed, another crew comes into play. Many of the station members are interested in the construction of equipment and get experience through actually constructing equipment of various kinds under the supervision of the chief engineer. The latest addition was the "combo board" used during the Illini Union activities night. This unit was completed only about fifteen minutes before the activities night commenced. That's really close planning but is typical of the highly integrated construction program.

All this could never happen, however, without the commercial department. Without commercials and the money obtained from them, there would be no WPGU. Under commercial manager Phil Lieb, this department has brought some leading companies to the attention of the listeners. Campus Cab, for example, is a regular advertiser on WPGU, keeping the students informed of their many new services to the U. of I. student body.

Another sponsor well known around the station is Lucky Strike cigarettes. All of the news programs are presented through the courtesy of Lucky Strike, who provides the United Press teletype.

Last but not least is the station manager, Bill Carmody. Bill is well known around campus for his interviews at the Union during the intermission at Club Sophisticate. He is also heard on some of the 11 p.m. classical music programs as well as many other WPGU features. He is also becoming known as the moderator of the "Twenty Questions on the Campus" program every Saturday evening at 6:30 from the Clark lounge.

Like the top man in many organizations, Bill's job is to make sure things get done—properly and on time. Although it sounds simple, this is really a full time job. Through it all, however, Bill still manages to keep his calm composure and good sense of humor.

No description of the station is complete without a few words on the technical aspects of carrier-current broadcasting. Since the station first went on

the air back in December of 1953, listeners have been getting the station "through the power lines."

In its operations WPGU studio engineers adjust the controls until the program material (audio) comes out of the studio equipment at the proper level for feeding the transmitters. It is then split eight ways by a network and sent to the eight transmitters via lines leased from the telephone company.

The need for multiple transmitters is one of the characteristics of carrier-current broadcasting. The transmitting antenna of each transmitter is the a.c. power wiring of a building or group of buildings. The transmitter output is directly coupled into all phases of the power line and from there radiated into the individual receivers. The signal will not pass through the pole line transformers, however, and thus one transmitter must be used for each area served by a different transformer.

LAR, for example, is served by one power transformer and therefore has one transmitter. The LAR addition, however, has a separate power system and must therefore be served by another transmitter. Incidentally there is no transmitter in the LAR addition yet, but its construction has high priority.

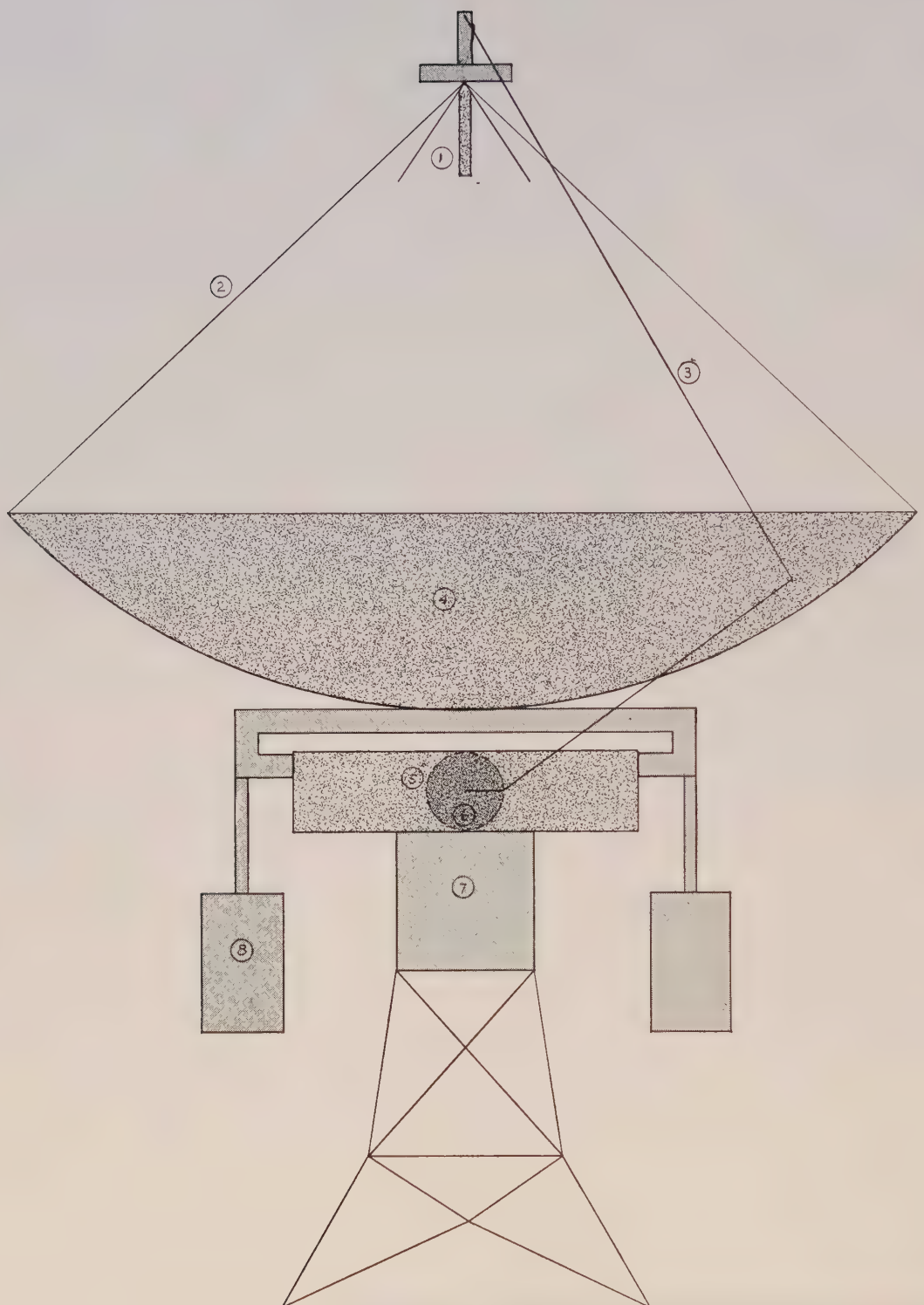
Due to the high initial cost of the transmitters (approximately $130), they have all been allocated to locations of high population density (number of students per pole line area). Although this currently means that most of the transmitters are feeding University residence halls, other areas will be better covered when equipment becomes available, both "greek" and "indie."

Transmitters are currently installed in Clark House (covering also Lundgren and Barton), Flagg House (covering also Noble), LAR, Newman Hall, Alpha Sigma Phi (covering Arbor Suites and many others), Evans Hall (covering also Busey), MRH Additions 3 and 4, and the PGU local, covering the PGU's and Stadium Terrace.

A rather elaborate control system installed at the studios allows each transmitter to be remotely turned on or off. Certain transmitter readings are also taken remotely at the studio as an indication of transmitter performance (although these readings are not truly comprehensive). In this way many defects can be noted and corrected without delay. Some defects, however, cannot be detected by this system and must be reported by the listeners.

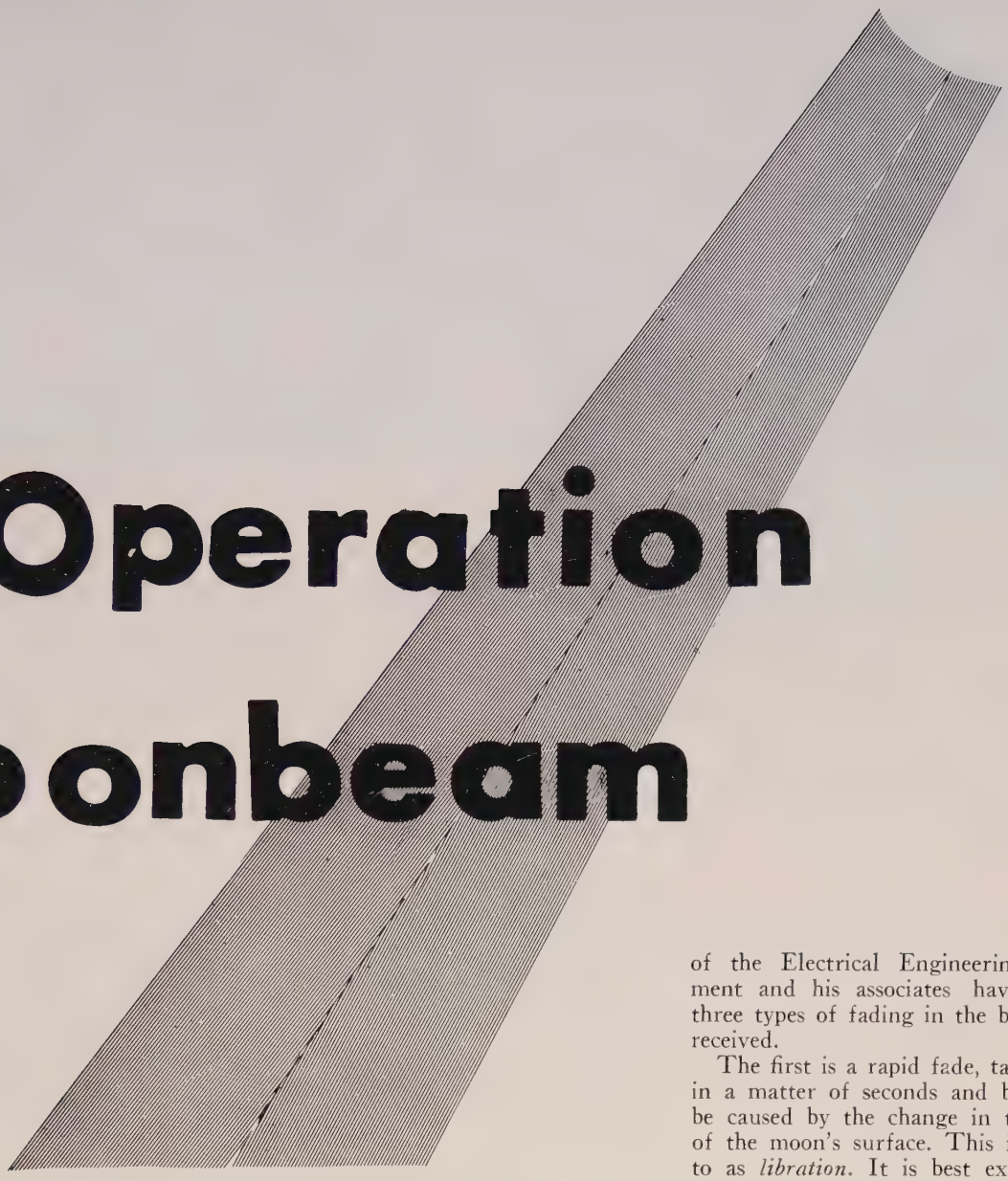
Time doesn't permit a complete description of the station. For those who are interested in more details, may we suggest that you drop by the station located at 1241 S. Euclid. Who knows, you may like it and decide to stay. Good personnel are always needed, so why not stop by and say you heard about them in *Technograph*.

PHIL LIEB knows his job so well he can do it with his eyes closed. Jim Dean is busy with some of the essential paperwork. Below, Howie Krause and Dick Adams discuss the significance of the news.



1 DIPOLE
2 SUPPORTING STRUT (PLEXIGLASS)
3 TRANSMISSION LINE
4 DISH
5 ELEVATION CONTROL
6 AZIMUTH COUNTERBALANCE (NOT SHOWN)
7 AZIMUTH CONTROL
8 ELEVATION COUNTERBALANCES

Operation Moonbeam



by Dave Penniman, M.E. '60

It is usually the freshmen who stand gazing with wide eyes at the various structures on campus. This semester, however, even the old experienced students were caught staring at a new addition, the giant antenna mounted on top of the Electrical Engineering building. Although many wild stories are floating around north campus, few of the sidewalk superintendents really know just what the antenna is doing up there. Perhaps we can enlighten a few about just what *is* going on.

The antenna itself is constructed of aluminum and in its entirety weighs nine tons. The dish is twenty-eight feet in diameter and weighs 1100 pounds. It is furnished to the University by the U. S. Army Signal Corps under a research contract.

The main purpose of the project is to make a study of the ionosphere by observing radio waves passed through it. The transmitting unit is located at Evans Signal Laboratory near Balmar, New Jersey. The unit here at Illinois is capable of receiving only. The waves are transmitted from New Jersey to here via the moon.

This type of project has been done before, the first time being in January, 1946, by the Signal Corps. Although the project has no direct connection with the I.G.Y., the unit can be used as a radio telescope if so desired.

The present project has brought to light many new facts. It has found that the waves change polarity in their trip to and from the moon. Also, the amount of signal lost or absorbed can be used to define the nature of the ionosphere.

One result is that Prof. H. D. Webb of the Electrical Engineering department and his associates have noticed three types of fading in the beam being received.

The first is a rapid fade, taking place in a matter of seconds and believed to be caused by the change in the nature of the moon's surface. This is referred to as *libration*. It is best explained in the following manner. As the moon rotates about the earth, the irregularities of its surface change position. The reflecting surface is therefore not uniform and hence the variations.

The second fade can be observed in a matter of minutes and is accredited to the structure of the ionosphere. Finally, there is a variation from day to day which is also caused by the structure of the ionosphere.

With this information and more to come, the men on this project hope to be able to define more closely the characteristics of the ionosphere.

One factor hindering progress on the project is electrical interference. The main source of this interference comes from the ignition systems of automobiles passing near the receiving center. Drivers, take note!

It will be interesting to watch the progress of this project as the semester proceeds. As soon as more information becomes available, the *Technograph* will report it.

$ $ $

2-$25 Awards

Two cash awards of $25 each will be awarded to the author of the best TECHNOGRAPH staff article and the best non-staff article submitted to the ILLINOIS TECHNOGRAPH.

Rules:

1. Articles must be submitted by the author not later than April 1, 1958.
2. It must not have been previously published.
3. It must pertain to engineering in some way.
4. All articles must be doublespaced typewritten.
5. Technograph staff members are eligible for only one of the prizes.
6. Some articles will be printed in the TECHNOGRAPH.
7. None will be returned, but they will be kept on file and may be printed later.
8. Please include pictures, if possible, and permission for us to use them.
9. Any number of articles may be submitted by the same author.
10. The Technograph editorial staff will be judges for the non-staff articles.

Notes:

1. Ten typewritten pages with pictures makes three pages in the magazine.
2. Use rhetoric department punctuation and capitalization.
3. Many national companies will be glad to send you photographs and information.
4. Get started now and get several articles written and submitted by April 1, 1958.

$ $ $

TECHNOCUTIE OF THE MONTH

Photos by Dave Moore

•

Coordination by Dennis Lantz and Pat Gaganidze

Introducing the Sweetheart of North Campus, Miss Judy Clark, Kappa Kappa Gamma.

Judy is certainly familiar with the engineering campus, as she has lived in Champaign-Urbana for all of her 19 years. Unfortunately for the engineers, she is now on south campus majoring in Elementary Education. A teaching career in the future? Perhaps, she says, and her green eyes twinkle, but first she'll be an airline hostess.

A pert 5'-4" tall, sporting 114 well-placed pounds, Judy would like to live in a large city, "at least for a while." A travel-bug, she's seen New York and Florida and doesn't want to stop until she's been to Europe.

A junior now, Judy is kept busy with things besides class work. She worked with Star Course for two years, is assistant editor of Illi-greek, and is freshman advisor for all unaffiliated town girls. For hob-bies Judy likes swimming, diving, and even cooking (she says she could use a little practice on the cooking . . . interested, gents?).

For those interesting in statistics, the vital numbers are 34-23-35, address is 605 W. William and the phone is 9260.

Know any cute girls?

. . . then tell us at Technograph!

SERIOUSLY, the Illinois Technograph is interested in obtaining nominations for the Technocutie of the Month. For many years we have been printing photos of girls who have won various queen contests on campus (or were among the finalists). We shall continue to print some of these pictures.

HOWEVER, and here is where you come in, we are interested in finding new talent. We are sure that there are many beautiful girls on campus who never appear in contests; you see them every day walking down the broadwalk. All we need to do is get names and phone numbers of these girls and we'll take care of the rest. Just fill in the blank and drop in any **University** mail box (not U. S. mail) or drop it off at 215 C. E. H. or the basement of Illini Hall (Daily Illini Office).

REWARDS are in it for you. For each girl selected, you will get a personally-autographed photo. Sound like a good deal? Then get busy!

Tear Here

ILLINOIS TECHNOGRAPH
215 Civil Engineering Hall

My nomination for Technocutie is_____

who lives at_____, phone_____

Her description is_____

_____

_____

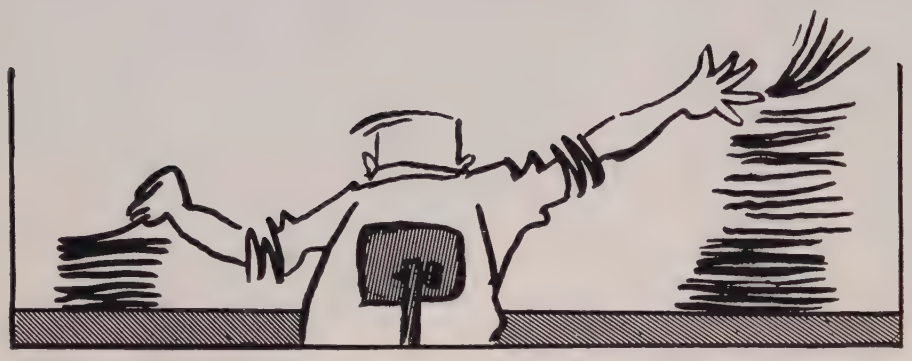
I am_____and live at_____

_____

_____, phone_____

(Signed)_____

Skimming Industrial Headlines



Edited by Dennis Lantz, G.E. '60

New Gas Purifier

The first fully automatic gas purifier and dryer, capable of operating indefinitely without attention, has been developed.

For use in metals, chemical, pharmaceutical, petroleum, electrical, and food processing and laboratory work, the "Dexo Dual Puridryer DMS" can deliver hydrogen with an oxygen content of less than one part per million and a dew point of better than -100°F, according to Baker. It also can be used with nitrogen, argon, helium, carbon dioxide, and saturated hydrocarbons.

The new device switches back and forth every 12 hours between two drying towers containing Linde molecular sieves. While out of use, each tower is heated electrically for a short time and allowed to cool while a small flow of gas is put through it to pick up and carry off the moisture. The purging gas then is burned in a converter, so that only water vapor is expelled into the room where the instrument is installed.

In the past, manufacturers requiring a continuous gas flow had to install two units and keep an attendant on hand to activate the dryers.

The Puridryer is rated at 100 standard cubic feet per hour maximum. Its maximum pressure is 5 lb. gauge.

The instrument removes oxygen by catalytically combining it with hydrogen at room temperatures to form water vapor. The platinum catalyst requires no reactivation.

A purified test gas to which an accurately measured quantity of electrolytically generated oxygen has been added is used to calibrate the instrument.

Marine Paint Soars

More than five million gallons of paints and coatings will be used this year for existing merchant vessels and craft under construction in private domestic shipyards, reports Chemical Week. The breakdown: some 3.7 million gallons for maintenance of existing merchant ships, about one million gallons for ships being built, and the remainder for foreign ships under repair in U. S. shipyards.

Electronic Conference

Three members of the electrical engineering department of University of Illinois have been named to key posts for the 13th annual National Electronics Conference to be held at the Sherman Hotel, Chicago, on Oct. 7-9.

They are George E. Anner, who is senior chairman of the board; M. H. Crothers, chairman of the proceedings committee, and W. L. Emery, chairman of the awards committee.

The National Electronics Conference is the nation's leading forum on electronic research, development, and application.

More than 10,000 persons—mostly scientists, engineers, educators, manufacturers, government officials, and students—are expected to attend the three-day technical meeting and exhibit at the Hotel Sherman.

Baby Yams Put in 'Incubator'

In Oklahoma, sweet potatoes begin life warmed by an electric blanket, reports Electrical World. Resistance-heated beds hasten their incubation period. After the seedlings are established, they are removed and sold to commercial growers.

Sodium Reactor News

Electric power was produced for the first time July 12 by heat from the Sodium Reactor Experiment (SRE) during tests of the nuclear reactor and auxiliary components.

The SRE, designed and built for the AEC by Atomics International (division of North American Aviation) is a part of the commission's program to develop economically competitive civilian power from nuclear energy.

The Southern California Edison Co. has installed electrical generating equipment adjacent to the nuclear reactor to convert to electricity reactor heat energy which the company purchases from the AEC.

The electricity produced was fed over the company's distribution lines. The experiment marked the first time a non-military atomic energy reactor has produced power for the generation of electricity by a private utility company.

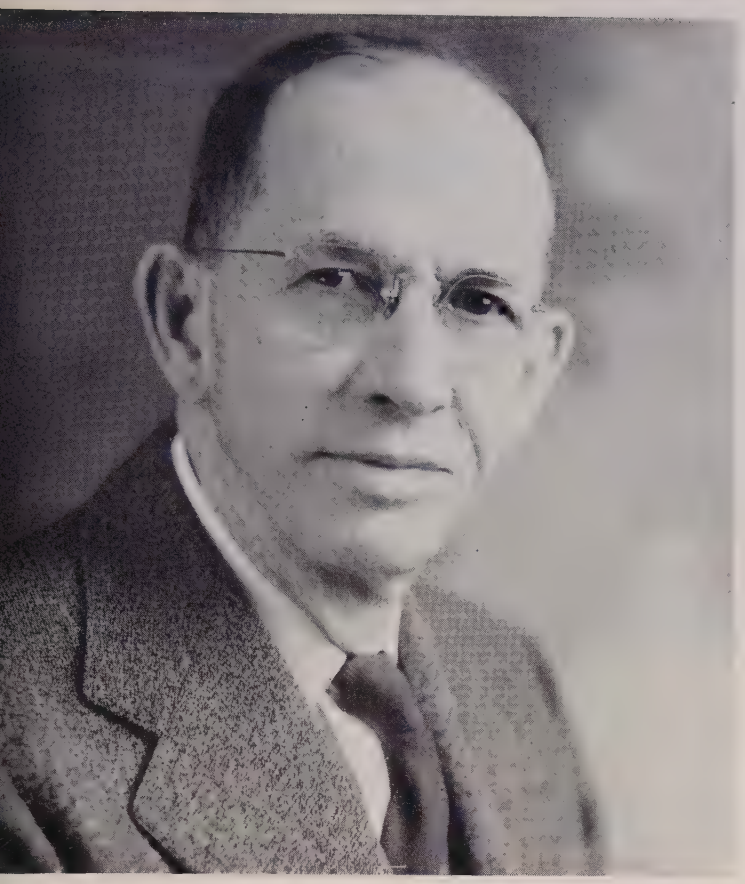
Following numerous experiments to test the operation of all components, the reactor plant will be operated at full-power late this year. The reactor is designed to produce 20,000 kilowatts of heat from which the Edison equipment will generate approximately 6,500 kilowatts of electricity. In the first test the generator operated at a level of about 1,000 kilowatts of electricity. The generating facilities will operate intermittently, depending upon the experimental operation of the reactor.

The Edison Company will share with other power generating organizations the information it gains from the SRE program. The plant is located in the Santa Susana Mountains about 30 miles northwest of Los Angeles.

Tank Car Goes Over The Waves

A tank car loaded in Baton Rouge, La., shipped to New Orleans by rail and then lifted onto a sea ferry for the trip to Havana, was the first tank-car shipment of antiknock compounds ever to go to a refiner overseas, reports National Petroleum News. The cranes that lifted the tank-car were big ones. They had to be—the car weighed about 40 tons, loaded with 6,000 gallons of compound.

(Continued on Page 46)



Prof. Huntington, Head of the Department of Civil Engineering, receives honorary membership in the American Society of Civil Engineers

Awarded Highest Distinction

HONORARY membership, the highest distinction bestowed by the American Society of Civil Engineers, oldest national organization in the United States, has been voted by its Board of Direction for Professor Whitney Clark Huntington, head of the Department of Civil Engineering, here at the University of Illinois.

The ASCE Constitution provides that "Honorary Members shall have attained acknowledged eminence in some branch of engineering or the sciences related thereto." Formal presentation will be on Oct. 16, 1957, at the annual meeting of ASCE in New York City.

In reviewing the careers of the New Honorary Members, ASCE stated that "Whitney Clark Huntington has devoted a lifetime to the training of civil engineers. For 38 years he has served as head of a Department of Civil Engineering and has brought distinction to two institutions, the Universities of Colorado and Illinois."

Born in Denver, Prof. Huntington received several degrees, including Doctor of Science, from the University of Colorado. He joined the faculty there in 1914 and became head of its Department of Civil Engineering in 1919. He came to Urbana to take a similar post in 1926, now serving as Professor of Civil Engineering and department head. Of his efforts here at the University of Illinois, ASCE said, "It is a consequence of his skillful administration that the successful transition was made from a small staff to a large and complex group needed for today's educational and research program, without loss in stature."

Recounting the numerous graduates who have become heads of civil engineering departments in many universities or otherwise have achieved particular distinction, the ASCE announcement took note, too, of the authoritative importance of his written works and acceptance by other institutions of the patterns established by Prof. Huntington's methods and policies.

Aerosol Sets Record

Aerosol sales in 1956 set a new record, 320 million units, reports Chemical Week. The products, valued at $320 million, total more than 33 per cent above the 1955 sales mark. Leading product was hair sprays, with sales of nearly 80 million units. Insecticides, out of the top spot for the first time, racked up sales of 52 million units.

An Easy Chair Control For Television Receivers

Television viewers can now enjoy an entire evening watching their favorite programs without getting up from their easy chairs. Westinghouse television engineers have made it possible to switch channels and lower the sound volume from any place in the room by putting to new use carrier current—the old method of sending radio-frequency signals over power lines.

The system is simplicity itself. The control signals generated by a small transmitter at the viewer's finger tips are carried over the house electrical wiring system to the television receiver. These signals actuate relays in the receiver that control channel selection and sound muting. The control system is particularly suited for use with receivers equipped with power tuning and electronic automatic fine tuning.

Carrier current has several advantages as a signal transmitting medium: the power required to operate the transmitter is easily supplied by plugging into any 115-volt a-c convenience outlet—and a path for the carrier-current signal results in relatively low attenuation, so that a low-power transmitter and relatively low-gain receiver will provide positive and foolproof remote control.

The two functions of the control system—channel selection and sound muting—are accomplished with two types of carrier signals. A continuous wave of the required duration activates both the channel-selecting relay and the sound-muting relay so that the television receiver can be tuned through program channels without sound blasting (picture muting is also provided to prevent annoying flashes). A modulated wave activates only the sound-muting relay. Four alternate carrier frequencies, in the 50- to 75-kilocycle range, have been chosen so that a random distribution of carrier frequencies can be obtained to prevent interference between systems if several are in close proximity.

The viewer selects channels or mutes sound by moving a two-position switch to either the "select" or "mute" position. When the select switch is moved to the "select" position, d-c voltage is applied to the oscillator plate circuit, and the continuous wave signal is produced; when the switch is in the "mute" position, 60-cycle voltage is applied to the oscillator, and the modulated carrier signal results. The switch will latch in the "mute" position to provide continuous muting.

Transmitter output is in the order of 12 milliwatts for continuous-wave operation, less for the modulated signal. Field testing has shown that this power level is sufficient for positive operation, yet low enough that receivers with control systems installed in adjacent houses supplied from the same power transformer will not interfere with each other if tuned to different carrier frequencies.

The operation of the carrier-current receiver is shown in the simplified symbolic diagram. The input circuit is set to receive any of the four carrier frequencies, and the signal is amplified in a two-stage amplifier. The two relay circuits are effectively in "parallel" at this point. The continuous wave signal is blocked from the sound-muting relay by the audio-frequency amplifier, but is rectified for the channel-selecting relay. This rectifier voltage raises grid voltage of the channel-selecting stage, increasing plate current and operating the current relay in the plate circuit.

The modulated carrier signal is also rectified by the rectifier stage, but its average value is not great enough to operate the channel-switching relay. However, the 60-cycle modulated signal is amplified by the audio-frequency amplifier to activate the sound-muting relay. An interconnection from the channel-switching relay to the muting-stage relay insures that sound is muted when the channel-switching relay operates, to eliminate sound blasting when turning through programmed channels.

Tractor Remote Control

A "robot" tractor than can be operated anywhere within range of the radio by which it is controlled is undergoing tests at the U. S. Army Research and Development Laboratories, Fort Belvoir, Virginia.

The tractor, believed to represent the first application of the remote control principle to a piece of construction equipment, may prove invaluable in construction work in radioactivate and combat zones. It may also be useful in various other tasks, such as fighting large fuel storage fires.

From a jeep or helicopter equipped with a standard military radio transmitter and a special control box, the operator can start and stop the machine, engage and disengage the gears, operate in forward and reverse, manipulate the dozer blade up and down, and activate the steering mechanism.

Normal operations can be performed from distances of up to 15 miles, the practical range of the radio, simply by manipulating the buttons on the control box. Army Engineers believe that the instllation of small television cameras on the tractor will give the remote operator additional knowledge and observation of the machine and give him the ability to work it without the need of information relayed by a visual observer.

The prototype is the standard commercial "Tournadozer" manufactured by Le Tourneau-Westinghouse of Peoria, Illinois. The only visible change to the machine is the substitution of a standard military radio receiving set for the operator's seat. Manual controls have been retained for conventional operations.

As a safety precaution, early tests have been conducted with the tractor and control point within viewing distance. It will be operated from greater distances as the test schedule progresses.

Oxygen Indicator

An oxygen indicator 20 times more sensitive than any such instrument previously available in the U. S. has been placed on the market by Baker & Co.

In addition to laboratory use, the device has process applications in atomic-energy work, metals treating, and the manufacture of such diverse products as chemicals, pharmaceuticals, electronic equipment, plastics, synthetic fibers, pigments, photographic supplies, petroleum derivatives, incandescent lamps, tobacco goods, and bottled industrial gases.

The Minoxo Indicator, as it is called, can measure traces of molecular oxygen in a wide range of gases, including hydrogen, nitrogen, ethylene, other hydrocarbons either saturated or unsaturated, helium, argon, and other inert gases. Precision indicators previously available could not handle certain of these gases, notably unsaturated hydrocarbons.

The new instrument has two ranges, 0-10 and 0-100 parts per million. When calibrated every eight hours, it has a conservatively estimated accuracy of plus-or-minus 5% of full scale deflection. The most sensitive indicator on the market heretofore had a minimum range of 2-200 ppm and was accurate to only plus-or-minus 1% of full deflection on that scale.

The Minoxo operates on an entirely new principle for instruments of this kind. The gas sample is passed through a galvanic cell consisting of a silver cathode and active cadmium anode in a potassium-hydroxide solution.

(Continued on Page 60)

Yes, we want engineers,

BUT

. . . we don't want just any engineer. We want engineers with ideas, engineers with drive, engineers who can stick with a job and work with other people to get it done. Scientists, business and liberal arts graduates, too.

Union Carbide has a marvelous potential. It's a top producer of many things, from petrochemicals to titanium, from molecular sieves to flashlight batteries. Its sales have soared from a half a billion in '47 to one and a third billion in '56.

And we plan to keep on growing. That's where you come in.

We need creative people. We spend a good portion of sales profit on research, but it takes creative people to make research effective.

We need people with initiative. They are the key to opening up new markets and to get production rolling. We introduce new products at the rate of two a month, and the rate is accelerating.

Representatives of Divisions of Union Carbide Corporation, listed below, will be interviewing on many campuses. Check your placement director, or write to the Division representative. For general information, write to V. O. Davis, 30 East 42nd Street, New York 17, New York.

BAKELITE COMPANY Plastics, including polyethylene, epoxy, fluorothene, vinyl, phenolic, and polystyrene. J. C. Older, River Road, Bound Brook, N. J.

ELECTRO METALLURGICAL COMPANY Over 100 ferro-alloys and alloying metals; titanium, calcium carbide, acetylene. C. R. Keeney, 137—47th St., Niagara Falls, N. Y.

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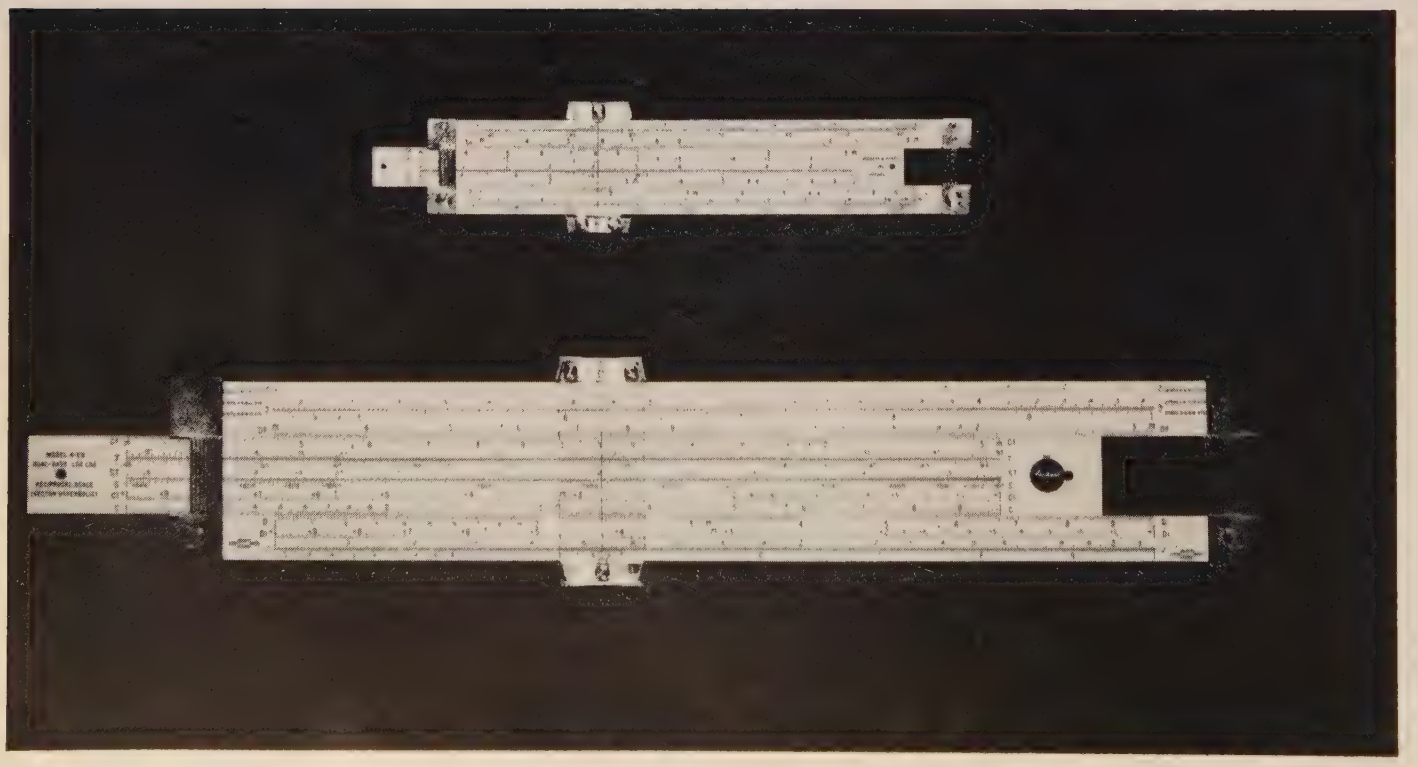
SLIDE RULES . . .

What's the DIFFERENCE?

by Don Georgi, E.E. '59



Greetings, fellow engineer!

I suppose by now you either have a slide rule or are considering buying one. If you are considering a rule for the first time, or think you need a bigger one, just stop for a moment to see if you can answer some questions to your own satisfaction.

Do *YOU* need a slide rule? Why? When? If so, what kind?

Got all the answers? If not, don't worry, because it won't affect your grade point average—yet!

Do You Need a Rule?

The answer cannot be a clear cut yes or no for every student. By this I mean that a slide rule is not a free pass through this university or any other. Then, too, you might be in some curriculum which doesn't have need of one. Dr. Hohn of our mathematics department, for instance, states that a student majoring in mathematics really would have no need for a rule. (As a sidelight he added that these students should have a knowledge of slide rule manipulations, since the rule is a tool of mathematics). Even engineering students taking courses in the math department will tell you that it is a rare moment that a slide rule is needed in one of these courses.

Or consider the case of one chemistry student of two years ago who went through his freshman year without a slide rule, and yet managed to get a perfect 5.0 average.

Yes, it can be done, but most engineering students, even the smart ones, find that a slide rule is necessary.

Why?

Will a slide rule help any student's grade point average? Will it do your work or think for you?

A story has gone around the north campus about one eager engineering student who, after hearing a salesman say, "This rule will do half your work," replied, "Fine, I'll take two of them!"

Fortunately engineers have no competition from their beloved slide rules. Just remember, you get no more out of a slide rule than you put in. The square root of 84 is still 9.17. If $\sqrt{21} \times 4$ is not the right solution to your problem, 9.17 won't do either.

If a slide rule doesn't think for you, you might then wonder where its value lies. Really, the little fellow violates the saying that you can't buy time; for time saving is its real purpose. Anything ordinarily done on a slide rule can with a pencil, paper, tables, and sufficient time be done the long way. But you will burn less midnight oil, have more time constructing coherent lab reports if the slipstick does your computations. For example, two years ago the two Physics 106 (second semester freshman course) hour exams had 26 and 20 separate multiplication, division, or trig operations, respectively. In each exam, slide rules saved at least ten minutes which could be used on some difficult problem or as time to check answers.

MOST SLIDE rule manufacturers provide excellent manuals with their rules. To supplement these, however, College Outline also covers slide rules.

When?

You needn't work yourself into a sweat if you haven't got a rule for tomorrow's classes. In fact just about any freshman can make it through the first semester without one. But you should think very seriously about a rule before you sign up for Physics 106. (You will find that it is recommended for the course.) After that, a slide rule will become your constant companion. In fact you'll probably find that you take it out more than you do girls. (Probably).

What Kind?

A quick walk through campus town will reveal a multitude of advertisements in book store windows, telling you just why some rule is especially designed for you. But each advertiser says that his rule is best for you. Who is right? Further investigation will show that there is no acknowledged "Rolls-Royce" of the slide rule industry. A Post owner will fruitlessly try to tell a market, this will be a good time to mahogany while at the same time an onlooking Pickett engineer snickers softly, knowing in his heart that metal is the only material for slide rule construction (his own unswaying conviction).

Since there is such a variety in the market, this will be a good time to practice engineering procedure of setting your requirements, getting all the facts, and arriving at the solution which will best fit your needs. Before considering a brand name, however, it would be a good idea to see just what scales you will need on a rule.

All the major slide rule manfacturers (Keuffel & Esser, Pickett & Eckel, Post, and Dietzgen) make rules with a variety of scales. An elementary rule consists of enough scales to multiply, square, cube, and work trig functions.

Larger rules include logarithm of logarithm (log log) and hyperbolic scales. Due to the cost of a rule, most engineering students believe that is best to get one large rule right away, rather than work up from a smaller one. If a good slide rule is given a reasonable amount of care, there is no reason why it should not last the duration of your engineering career. You may not be sure that engineering is for you, though, and decide to get a little one to carry you through two or three semesters. In that case you would probably consider the ten inch Mannheim type rule which has the A, B, CI, C, D, K, S, T, and L scales. Both K & E and Post sell a Mannheim for $2.50.

If, on the other hand, you are determined to make your first rule your last, you will then look to a rule with log log, and possibly vector, scales.

A poll of what kind of rule student or professional engineers use would show that most rules in use today are of the log log variety. This type of rule will be sufficient in just about all the major fields (aero, civil, electrical, industrial, mechanical, and metallurgical). The reason for this sufficiency is that a log log rule will do any computations of the lesser rules plus the tedious and time-consuming exponential calculations.

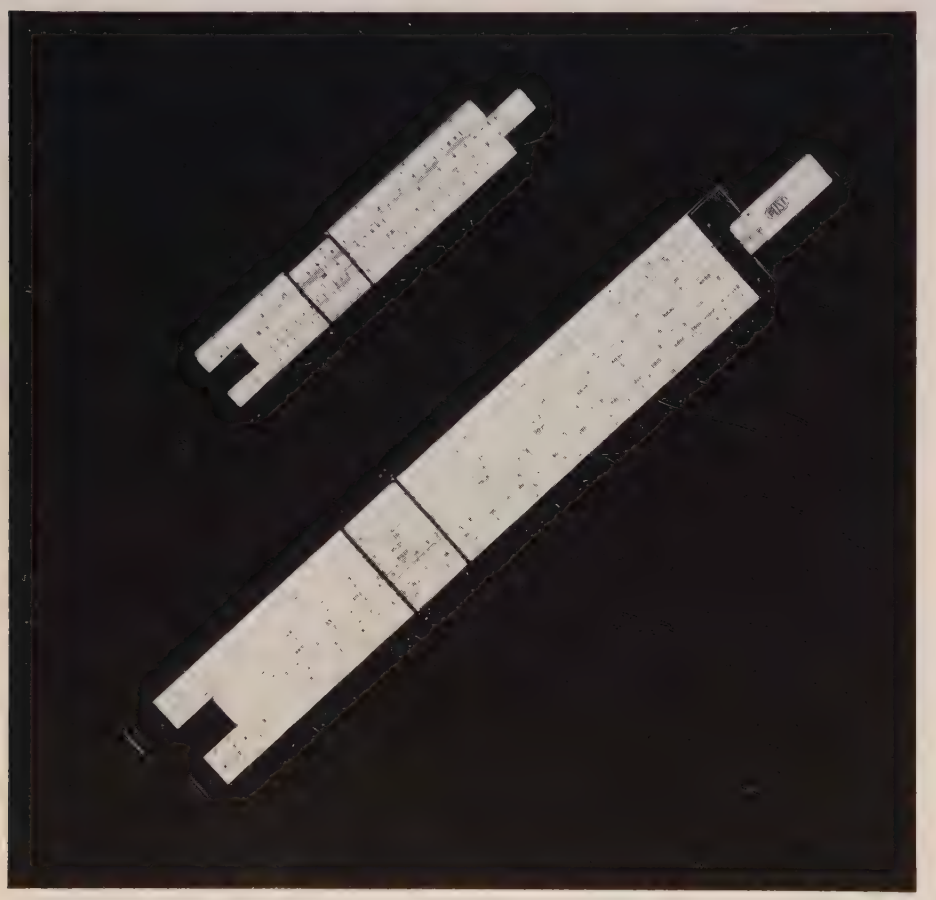
Find that $e^{3.55}$ is 34.8, for example is a five-second calculation. To get the complete picture of what these rules will do, get an instruction book from one of the fellows in your house or look at a slide rule book in the library.

Vector Rules

The vector slide rule is considered to be the ultimate in slide rules. Vector rules will again do all the things a log log rule will do and have three scales left over to be used for hyperbolic functions. This rule is not as popular as the log log variety, though, because engineers ordinarily don't find enough use for these hyperbolic scales.

They are usually used by the people in the electrical engineering power option and engineering physics majors where hyperbolic functions occur frequently in sine wave combinations and field problems.

Having briefly gone over the differences in the most widely used engineering slide rules, we will next consider what the individual slide rule manufacturers have to offer in the line of ten-inch log log and vector rules.



THE BIG and little of slide rules. Next to the standard ten inch rule is the increasingly-popular six inch size.

Keuffel & Esser

Keuffel & Esser Co. is the pioneer of quality slide rules in the United States. By 1891, they were making slide rules which had scales on the front and back. Through the years K & E has modified their rules so that engineers could have the most complete and yet simple calculating tool available. The same quality workmanship in their drafting equipment is found in K & E slide rules. Mahogany is the basic material used in K & E rules because of its durability and stability. To keep this slide rule operating freely under the most humid conditions, it has been suggested that a little talcum powder be applied to the mating surfaces. Not only would you have an easy sliding rule, but you would also be the sweetest smelling engineer in the lab. (Especially recommended for chem engineers!)

The white facings covering the mahogany are engraved line by line with a machine. This "engine dividing" ensures precision reading and long life. (*Author's note*: I have seen a 25 year-old K & E rule which, although yellowed with age, was just as accurate as the day it was made.)

K & E's "log log duplex decitrig" is the most popular rule they make. Its scales will do simple and complex multiplication, squares, square roots, cubes, cube roots, and proportions; work trig functions (in degrees and decimals of a degree); and do calculations involving powers and roots of numbers ranging from 0.00005 to 22,000. This rule in a chamois-lined leather carrying case is $25.50. A rule which is similar to this one, but having the trig scales represented in degrees and minutes, is available at the same price. Most slide rule operators prefer the decimals of a degree, however, rather than minutes.

The same scale arrangements can also be purchased on Ivorite, a trade name for a plastic material. This rule sells for $15.00. "Log Log Duplex Vector" is a complicated-sounding name given to K & E's rule designed to overcome complexities. This rule has all the scales of a "Duplex Decitrig" except the L (log) and K (cube) scales. Removal of the L and K scales does not seriously hamper the versatility of this rule, as logs and cubes or cube roots can be found with the aid of the LL scales.

Through years of experience, K & E has attempted to produce rules which are as easy to read as possible. The best way to express their method is *consistency*: consistency of scale relationships, reading direction, and color relationships. All the scales relate to the C and D scales, black numbers increase to the right, red numbers increase to the left, direct functions read on like colors, and co-functions read on opposite colors.

Pickett & Eckel Rules

The "new look" this year in the slide rule industry has been introduced by the Pickett Company. In the past they have built a fine reputation for

producing good rules and have now introduced a few new developments for 1958 which are designed to make Pickett rules more convenient and accurate. Among the most easily noticed changes are the redesigned end plates and cursor bars. Other developments are C, D and CI scales on both sides, log log reciprocal scales on one side, and extended log log range.

The basic material used in these rules is lightweight metal. These rules can be purchased with the regular black and white face or with black graduations on a yellow face. Pickett Co. explains the use of black and yellow as giving glare reduction and optimum contrast. The metal alloy construction insures freedom from warping and doubles as a neat defensive weapon in times of emergency. Pickett's graduations are advertised to be permanently positioned to ± 0.000275 inches.

In the log log variety, Pickett's "Model 800" has the same versatility as the "Log Log Duplex Decitrig," is scale-consistant to the D scale but is not color-coded. This rule in a saddle leather case sells for $18.

Pickett's vector rule, Model N4 ES, might be considered the "Goliath" of the slide rule world. Thirty-two scale arrangements line its faces: 25 ten-inch scales, one 30-inch scale, two 20-inch scales, and 80 inch LL scales. The hyperbolic Sh and Th scales cover the same range as K & E's, but the LL scales are 20 inches longer and range from 10^{-10} to 10^{10}. They retain the L scale, and have a K scale three times as long as the "Model 800." As on the other rules, D scale consistency is maintained. In short, this rule is like a modest fish . . . enough scales to cover everything.

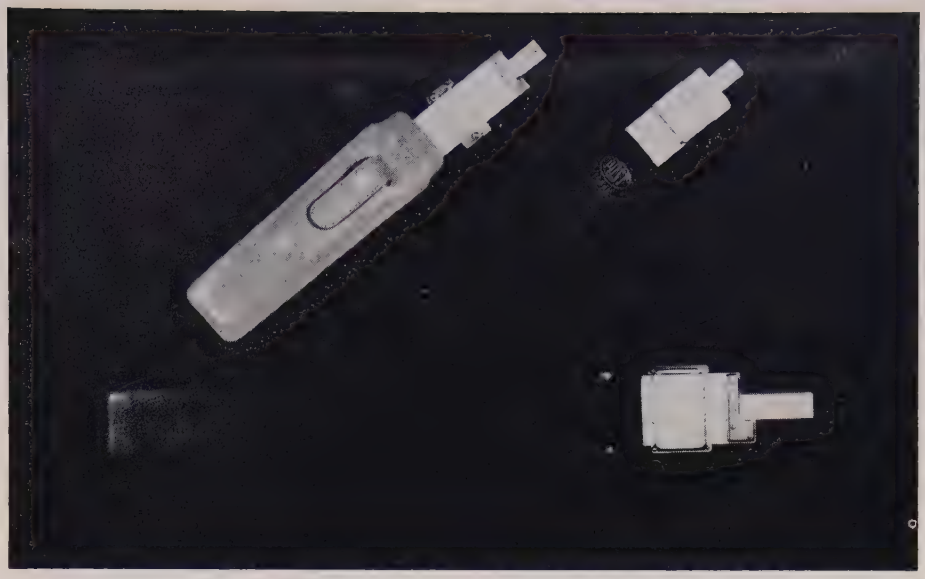
Post Co.

Engine divided graduations on a white celluloid face give the Post rules a striking similarity to K & E's. But under the face you'll find laminated bamboo rather than mahogany. Post people believe that the "natural sealed-in silica particles provide self lubrication." The bamboo is supposed to operate freely under any climatic conditions. (Maybe this is the thing you should take with you when you test your ball point pen that writes underwater).

In the field of log log rules, the Post Co. has its "Versalog," which sells for $26.25 with a leather case.

It is easy to see that the "Versalog" has caught on very well on our campus when you notice all the reddish-brown cases with the *Post*-labeled covers.

To gain their popularity, Post rules have offered a 20-inch square scale and LL scales which are 80 inches long (range 0.00005 to 22,000). For convenience, all the LL scales are located on one side, the consistant color coding keeps related scales together, and their end zone designations show quite clearly scale ranges. Post rules, like K & E and Pickett, all have accompanying instruction books which quite clearly explain and give examples of the slide rule operation.



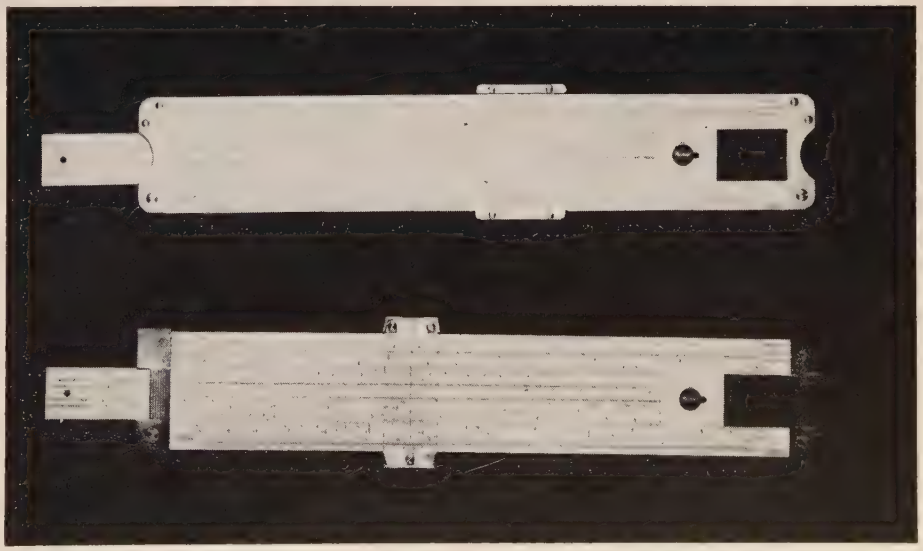
COMPLETE WITH cases, here are three different varieties. Without supplemental information many students are confused as to which one is better for them.

Extended Range Scales

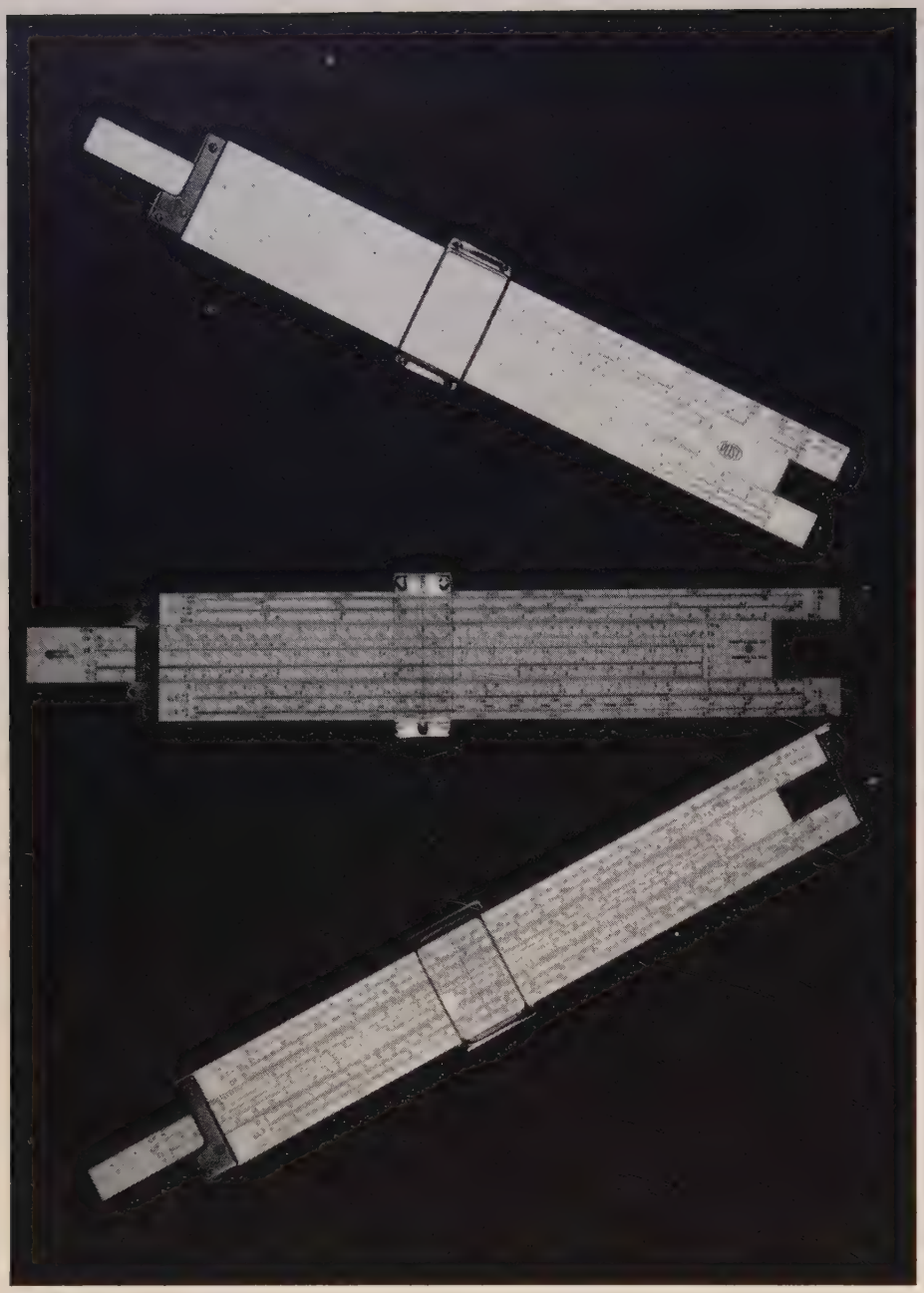
You may have noticed by now that the three above-mentioned manufacturers hold different ideas about extended range scales. K & E feel that a ten-inch A and K scale and 60-inch LL scales are sufficient. Post also thinks that ten inches are enough for the K scale but make their square scale 20 inches long. (Notice that the Post LL scales cover the same range, but are longer). Pickett uses the 20-inch square scales on their Model 4 ES but extends their cube scale to 30 inches. For even greater variety, the LL scales are just as long as Post's but have a wider range. It must be left up to you to decide which will be best for you.

Decide!

All of the rules mentioned have well-founded reputations among engineers. Remember that the rule you choose will probably be with you throughout your career. Talk to your classmates or fellows in your house about the rules. If necessary, see some professors about which rule is recommended in your field of engineering. And, lastly, see a reliable dealer for the slide rule of your choice.



PICKETT AND Eckel have come out with a new line. The top is the older model while the new one at the bottom can be readily identified by the ends.



History of Slide Rules...

What

The history of the slide rule begins in the year 1614 when John Napier, a Scottish mathematician, theologian, and inventor, published a work in Latin entitled *Canonis Descriptio.* In this work, he detailed his invention of what he called "artificial numbers." The principle on which these were based is the correspondence of an arithmetical and geometrical progression of numbers.

To these artificial numbers, Napier published a work called *Rabdologia*—a method of multiplying and dividing with numerating rods, which came to be known as "Napier's Bones." The method was based on the use of the logarithms.

Napier, in his *Canonis,* gave no explanation of his basis for calculating his logarithms; but the importance of his invention was recognized by an English mathematician, Henry Briggs, who wrote to Napier:

"My Lord, I have undertaken this long journey purposely to see your person, and to know by what engine of wit and ingenuity you came first to think of this most excellent help in astronomy, viz. the logarithms; but, my Lord, being by you so found out, I wonder nobody found it out before, when now known, it is so easy."

Briggs proposed to Napier an alteration of the latter's hyperbolic or natural logarithms to a system in which unity is assumed as the logarithm of the ratio of 10 to 1 (in other words, decimal logarithms). Napier agreed to this change; and in 1617, Briggs published the revised logarithms.

The revised logarithms are called Briggsian logarithms, and are known as logarithms to the base 10.

Napier's are called Napierian logarithms, and known as logarithms to the base *e.* They are usually used in higher mathematical analysis.

Three years later, in 1620, Edmund Gunter, an English mathematician, astronomer, and inventor (famous for Gunter's Chain, Gunter's Quadrant, and Gunter's Scale) evolved Gunter's line. This was a logarithmic line, the embryonic beginning of the modern slide rule. It was two feet long, and multiplication and division were effected on it by manipulation of dividers.

The following year, a William Oughtred eliminated the dividers simply by sliding Gunter's scales against each other—and thus the modern slide rule was born.

Other developments followed; in 1630, Delamain's circular slide rules, both flat and cylindrical; and in 1654,

Went Before

. . . excerpts from a talk by
Mr. Thomas of K & E Company

Bissaker's slide rule, the first in which the sliding scale moved between two fixed elements in the modern manner.

Sir Isaac Newton made his contribution in 1675 when he developed a method for solving cubic equations by using three parallel logarithmic scales.

In 1778, the indicator, which facilitates settings and readings, was introduced; but did not come into universal use until around 1850.

A big stride forward was made in 1815 when Dr. Peter Roget of the University of London invented the "Log Log" scale; however, this scale did not come into general acceptance until about 30 years ago. Today, however, the Log Log Scales are regarded as among the most valuable on the modern slide rule.

In 1850, Lt. Mannheim of the French Army developed the slide rule which still bears his name, which became the commonest type of slide rule, and on which all other modern general-purpose slide rules are based.

George Fuller of Belfast, Ireland, invented in 1878 a cylindrical slide rule with extra long logarithmic scales; and in 1881, Edwin Thacher of New York invented another calculator of cylindrical type.

At about this period, the American slide rule industry began to take an important place in the slide rule field. Until K & E began the manufacture of Mannheim-type rules in this country, slide rules had been imported from Europe.

In 1891, an entirely new idea in slide rule construction was introduced. This construction made it possible to have scales on the front and back surfaces of the slide rules and involved the use of the double indicator referring to all scales simultaneously.

The basic scales, known as the C scale and the D scale, were augmented around 1900 by the folded scales CF and DF and the inverted-folded scale CIF. These scales reduced the amount of manipulation and slide resetting needed for extended multiplication and division operations, and proved to be valuable time-savers.

These scales were folded originally at $\sqrt{10}$ but were later improved by folding them at pi. This made it possible for pi to be used as a factor without the necessity of making separate settings for this value.

In 1924, the LLO scales were introduced which, referring to scales A or B, extended the range of LL scales to values of less than one. Later, another development was the dividing of the trigometric scales into degrees and decimals of degrees. This made possible the elimination of all non-decimal subdivisions from the slide rule.

In 1939, another improvement was made in scales and scale arrangement whereby all the trigonometric scales were placed on the slide and made to refer to the C and D scales. This arrangement saves a considerable amount of time in problems which involve continuous calculation and progressive manipulation, since it is not necessary to take any reading other than the final answer.

A further far-reaching improvement was made in 1947 when the Log Log scales were referred to the C and D scales for values of less than one, which formerly were referred to the A and B scales. At the same time, they were correlated with all the other scales of the slide rule (now known as the Log Log Duplex Decitrig) and mated to the Log Log scales for values of more than one. This development gave maximum efficiency to the modern slide rule.

During all these years, of course, there were other slide rule developments. Most of these, however, took the form of scales or rules for special purposes. For example: there have been slide rules devised especially for such fields as surveying, artillery fire control, chemistry, air-conditioning, radio, hydraulics, and so on.

The slide rule, as we have seen, is an instrument for mechanically effecting calculations by the use or aid of logarithms. Thus, it is grounded in Mathematics; and just as Mathematics is a tool of Engineering, so the slide rule is a tool of Mathematics.

Now the fact is that virtually any calculation which can be put in the form of addition and/or subtraction of the functions of the variables can be solved on a regular or special slide rule, and many calculations can be so reduced

if they are put into logarithmic form.

By the use of logarithms, multiplication and division of numbers is facilitated (especially in the case of large numbers) by becoming simply the addition and subtraction of the logarithms of those numbers. Here is an example:

$$\begin{array}{r} 3 \\ \times 5 \\ = \ 15 \end{array}$$

$$\begin{array}{r} \log 3 = .4771 \\ + \log 5 = .6990 \\ \hline 1.1761 = \log 15 \end{array}$$

Similarly, logarithms facilitate raising numbers to powers (by multiplication) and extracting roots (by division). Here is an example:

$3^2 = 9$

$$\begin{array}{r} \log 3 = 0.4771 \\ \times 2 \\ \hline = 0.9542 = \log 9 \end{array}$$

That is what logarithms do for calculations. In other words, again, logarithms simplify calculations.

The basic logarithmic scales of the slide rule are scales C and D. They are full-unit length scales, usually reading left to right, and are identical. The C scale is usually on the slide, and the D scale on the body.

Allied with these scales are the CI and the DI scales. These are identical with C and D, except that they are inverted—that is, they read from right to left.

The CF and DF scales are the same as the C and D scales except that they are folded. This means that they are cut at pi, 3.1416, with their indices 1 and 1 abutting at an intermediate point along the rule.

The CIF scale is the CF scale inverted.

The foregoing are the scales used for multiplication and division. The folded and the inverted scales are "convenience" scales which give faster and more accurate results in lengthy multiplication and division.

The A and B scales are identical, A usually being on the body of the rule and B, on the slide. Each consists of two logarithmic scales of half-unit length in end-to-end relation.

These scales are usually used to obtain squares and square roots.

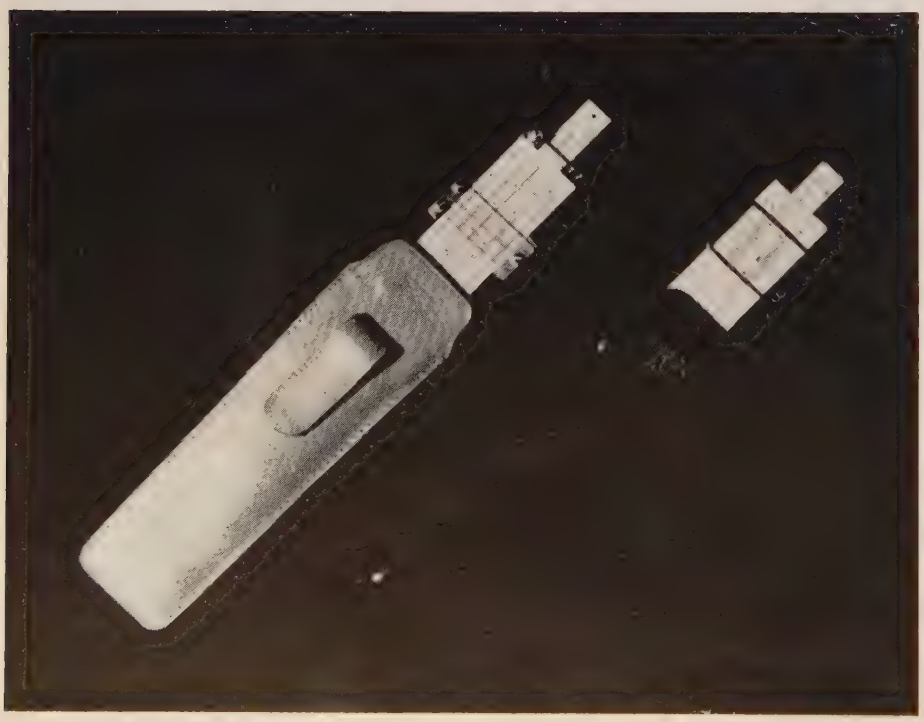
The K scale consists of three logarithmic scales in end-to-end relation, each scale of one-third unit length. It is used to obtain cubes and cube roots.

Scale L—the scale which is not divided logarithmically—is graduated to 10 equal divisions and is used to obtain common logarithms.

S is a sine scale, graduated in accordance with the logarithms of the trigonometric functions of angles; correspondingly, T is a tangent scale, graduated in accordance with the logarithms of the tangent values of angles.

ST is a scale graduated for angles from approximately .6° to 5.7°, which is used for sines and tangents since the sine and tangent values of these small angles are practically the same.

Six very important scales are the LL1, LL2, and LL3; and the LL01, LL02, and LL03. All of these are known as Log Log scales, and they greatly facilitate the otherwise difficult problem of finding the value of a power of a number, or a root thereof (and finding the root, incidentally, is such a laborious and complicated process that few persons, even among mathematicians, will attempt it without a slide rule or a table of powers and roots).



The LL scales cover a range of numbers greater than 1 from 1.01 to 22,000.

The LL0 scales cover a range of numbers less than 1 from 0.99 to 0.00005.

The LL and the LL0 scales are mated scales, the mates being: LL1 and LL01, LL2 and LL02, LL3 and LL03.

These mated pairs have this relationship: Opposite numbers on mated scales are reciprocals of each other. For example:

Reciprocal of 2 is 1 divided by $2 = \frac{1}{2}$.

To find reciprocal of 2, using slide rule:

1) Set hairline over 2 on LL2 scale.

2) Under hairline on LL02 scale read $0.500 = \frac{1}{2}$.

Reciprocals can also be found by means of the C1 scale, but they can be found to much closer values on the LL scales.

The six Log Log scales are in close association with the constant *e* which is the base of natural logarithms (as opposed to common logarithms). This constant is used again and again in the mathematics of engineering; its value is approximately 2.718, and it falls at the right index of the LL2 scale and the left index of the LL3.

When the Log Log scales are used in connection with the D scale, powers of *e* can be found, since the Log Log scales are so constructed that when the hairline is set to a number on D, the hairline on a Log Log scale yields the value of *e* to the power of that number.

Therein lies the basic theory of the Log Log scales; and similarly, these scales provide the means of finding powers of any number. These scales also make possible the finding of logarithms to the base *e* and likewise logarithms to any base.

It is to be noted that while the range of the Log Log scales is from 0.00005 to 22,000, methods exist for dealing with numbers below or above this range.

The reasons why engineers make such extensive use of the slide rule have been defined as follows:

1) Its small size makes it handy to carry around.

2) The price of a good slide rule is not so high that one can not afford it.

3) The rapidity and degree of accuracy of slide rule calculation make the slide rule an ideal calculating instrument for the engineer.

Since the whole idea of using the slide rule is to obtain rapidly the results of mathematical calculations which by ordinary rules of computation would require excessive time and effort, it is important to use a correct, that is to say, the most suitable type of slide rule.

Classified by purpose are two types of slide rule: 1) the General Purpose Slide Rule; 2) the Special Purpose Slide

Rule. For your present needs and for your foreseeable professional needs, the General Purpose Rule is the type to use.

Classified by shape or form, there are three slide rule types: 1) Straight; 2) Circular; 3) Cylindrical. The cylindrical is so little used today that it can be classified as a Special Purpose Rule. The straight is the type used and preferred by most persons.

The straight General Purpose Slide Rule can be used ideally for a wide field of mathematical operations: multiplication, division, involution (i.e., raising to powers, eg. squaring) and evolution (i.e., extraction roots, e.g. $\sqrt{2}$), finding logarithms of numbers, and sines, cosines, tangents, etc. of angles.

In using the slide rule, what kind of accuracy is to be demanded and expected? That depends on two things: the nature of the calculation and the length of the slide rule.

With respect to the slide rule, it is to be noted that a 5″ slide rule will give results to 2 significant figures; a 10″ slide rule to 3 significant figures; and a 20″ slide rule to 4.

With respect to the calculation, it is to be noted that most engineering calculations do not often contain data of any greater accuracy than that—in other words, the data with which you will be working are themselves not exact enough to require any further degree of accuracy in the slide rule.

Occasionally, in your future work, you may encounter problems where greater accuracy will be necessary—but even there, you will use your slide rule to check results obtained by other methods of calculation.

As we traced the historical development of the slide rule and made reference to the devising of new scales and new scale arrangements, you noticed, very probably, the effect and the aim of these changes: a constant process of simplifying, standardizing, and achieving consistency.

One example of simplifying is the elimination of the enumerating rods, the "Napier's Bones" which we mentioned earlier.

The example of standardizing is found in the fact that most slide rules today as classified as 5″ size, 10″ size, and 20″ size. The 5″ is a vest-pocket version; the 10″ is the standard everyday model, which is the most used; and the 20″ is a desk model. Speaking parenthetically and paradoxically, a 10″ slide rule, for example, is more than 10″ long; it is the D scale and its allied scales to which the dimension refers. But, still speaking paradoxically, the scale is not 10″—its real length is 25 cms., which is almost 10″. In other words, in this country, we seem to prefer to call something the 10″ it *almost* is rather than the 25 cms. it *actually* is. (There, I suppose, is the reason for the paradox that our legal unit of length in this country is the meter while the actual unit of length which we use is the yard).

The matter of consistency, so long pursued over the years, has been well defined as the Principle of Consistency. Slide rule inventors, designers, and manufacturers have aimed at this principle for years, but it is only relatively recently that it was fully attained. It may be defined as comprising the following:

1) Consistent scale relationships.

2) Consistent indication of reading direction.

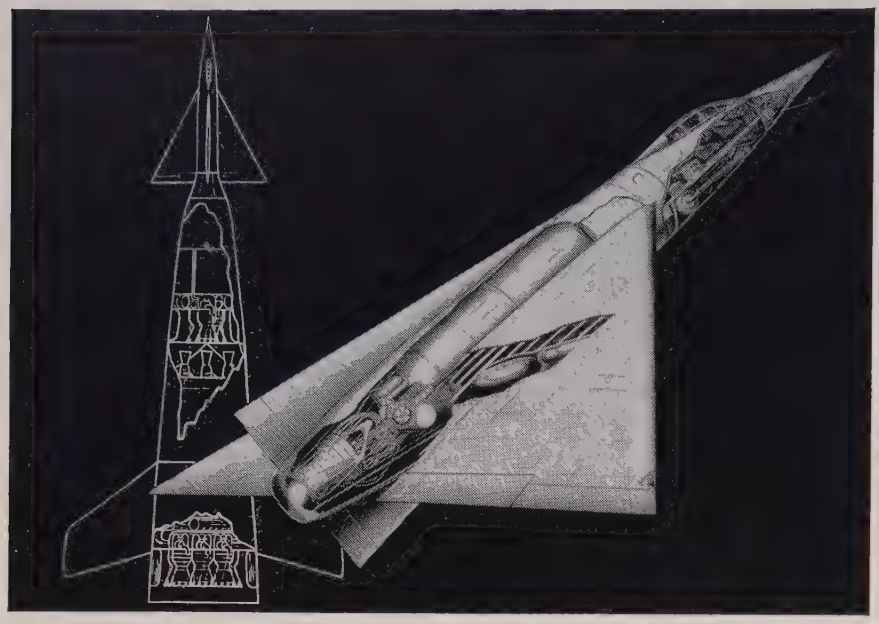
3) Consistent color relationships.

And when we have said all that, we have said just about all that is necessary to be said about the underlying principle, the background, of the modern engineers' slide rule. In so doing, we have traced the origin and development of the engineers' slide rule as we know it today; and at the same time, we have been able to observe how much we owe to those of long ago who first perceived and developed the value and the importance of the idea of the slide rule.

It is the same with all things, technical and non-technical, scientific and non-scientific: a knowledge of the past facilitates an understanding of the present.

(Photos by Dave Moore, Technograph photographer).

MARS outstanding design **SERIES**

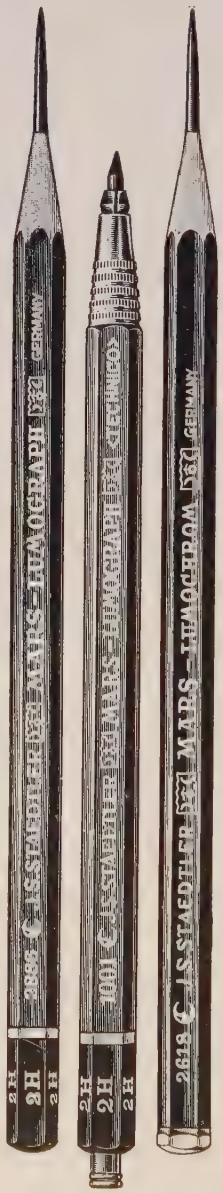


3 stages to space

The designs that will make news tomorrow are still in the "bright idea" stage today—or perhaps projects under development like this three-stage, two-man space ship. Drawn by Fred L. Wolff for Martin Caidin's "Worlds in Space," the rocket craft would start out as shown in the reverse drawing at left, shed its propulsion boosters in two stages as fuel is exhausted, and end up as the trim plane-like ship at right. Ship is planned to orbit a hundred miles above earth, return safely after one to two days.

No one knows what ideas will flower into reality. But it will be important in the future, as it is now, to use the best of tools when pencil and paper translate a dream into a project. And then, as now, there will be no finer tool than Mars—sketch to working drawing.

Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and — last but not least — the Mars-Lumochrom, the new colored *drafting* pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.



The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom colored *drafting* pencil, 24 colors.

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SKIMMING

(Continued from Page 46)

Magnetic Digital Tester

Rese Engineering announces the latest in its line of specialized pulse equipment. Model 1020 Programmed Current Pulse Generator is a "packaged" system, providing precisely controlled, fully programmed current pulses for the research development and production testing of digital systems and components.

The 1020 is distinguished by its ability to generate stable, high-level current pulses from a high source impedance, making it especially effective for use in analyzing highly inductive magnetic elements or for driving complete magnetic core logic systems. Incorporated in the instrument are an extremely flexible program generator; highly stabilized, heavy-duty power supplies; two negative and two positive output current drivers. Operating at 525 volts DC, two current drivers deliver negative pulse currents to 3 amperes from source impedence as high as 20,000 ohms, while two deliver positive pulse currents to 4.5 amperes from a voltage-type source.

Programming is based on an eight step, periodically repeated pattern, with a maximum step repetition frequency of 200 kc. Pulse repetition frequencies of up to 400 kc. may be obtained through incorporation of both a primary and a controlled delay secondary pulse during each step. Using the Rese Program Delay system, the program may be automatically stopped at any one or two of its eight steps and made to repeat the scheduled pulse up to 2000 times. In addition, any one or two adjacent step pairs may be repeated up to 1000 times.

Enabling the engineer to exercise full control over the final current wave shape, primary or secondary pulse width is continuously adjustable from 0.5 microseconds to 50 microseconds. Linear and exponential rise time is continuously variable from 0.08 microseconds to 2 microseconds, while exponential fall time is continuously variable from 0.15 microseconds to 2 microseconds. Output amplitude is highly stabilized, remaining constant over duty-factor extremes, and at average output current levels approaching half an ampere, positive or negative.

Other features of Model 1020 include synchronization with external equipment before any one or more discrete pulse events, ten turn current controls on all four amplifiers, forced, filtered air cooling and complete incorporation of the system into a single, standard relay rack.

New Atom-Smashers

A new design for high-energy atom smashers and a new way to plan and pre-test them by using an electronic computer were revealed here at the University.

A model of the new design which was put into operation at the Midwest Universities Research Association laboratory in Madison, Wis., worked perfectly at the first try.

Precise design and mathematical pretesting are given credit for this by Prof. Donald W. Kerst who supervised construction of the machine while on leave from the University of Illinois physics department to serve as technical director for MURA.

"Use of an electronic computer provides a revolutionary method for designing accelerators," Prof. Kerst said here today. "This saves years of design and test time."

Most of the mathematics for the new machine was done with the ILLIAC, the University of Illinois electronic digital computer. A year ago when the MURA laboratory was established at Madison, an IBM 704 computer was installed. Prof. James N. Snyder of Illinois has been MURA computing division head.

Parts for the model of new machine were built at Illinois and taken to the MURA laboratory at Madison for final assembly. The machine uses the "fixed field, alternating gradient" principal suggested by Prof. Keith Symon, University of Wisconsin physicist with MURA and announced two years ago.

Its new feature is the use of spiral magnets, an idea originated and developed by Prof. Kerst. These reduce the size of the machine to one-third that of a "reversed - field - radial sector" FFAG principal electron accelerator such as MURA built 1½ years ago.

The spiral magnets curve outwards from the center of the machine. The six magnets of the model are each 2 feet long and increase in width from 3½ to 7 inches between center and edge. The machine is 4 feet in diameter, weighs 1,000 pounds, and produces electrons with energies of 30,000 to 300,000 volts.

The model, and its method of planning by use of the electronic computer, pave the way for construction by MURA of two 15-billion volt machines each having some 40 magnets each 100 feet long.

Prof. Gerald P. Kruger of Illinois, who served as MURA laboratory director until Sept. 1 and earlier as the association's president, explained today that MURA, an organization of 15 Midwest universities, backed by the AEC, hopes to regain the lead in high-energy atomic research for America.

Today the world's biggest atom-smasher is a 10-billion volt machine in Russia. Twenty-five billion volt machines are being built at the Brookhaven, National Laboratory on Long Island, and in Geneva, Switzerland. The Russians are planning a 50-billion volt model.

Prof. Kruger said that MURA plans two 15-billion volt machines, with high-energy atomic particles from one smashing into those shooting from the other. This arrangement would eliminate the energy-consuming recoil effects which result when high-energy particles bombard stationary ones. By eliminating recoil this would give an effect equal to a single 500-billion volt machine.

"With successful completion and operation of the spiral sector model, MURA has demonstrated the feasability of both basic FFAG types and the organization has developed the necessary techniques for handling the most advanced accelerator problems," Prof. Kruger said.

In rotation of responsibilities among MURA member institutions, both Prof. Kruger and Prof. Snyder returned Sept. 1 to Illinois. Prof. Kerst was on the Illinois campus several days en route to San Diego, Calif., where he will head a General Atomics $10-million project on control of thermonuclear energy for peaceful use.

He explained that fantastically complex mathematics are involved in designing the curved magnets and the machine to use them. The reason lies in the technical term "non-linear dynamics."

This mathematics was done by the electronic computer, which also served to pre-test the machine, checking every detail and exploring the effects even of imprefections and errors, such as a magnet out of place. The test model is proving the predictions of the computer.

Universities which are members of MURA are Illinois, Wisconsin, Minnesota, Purdue, Indiana, Michigan, Michigan State, Iowa, Iowa State, Ohio State, Kansas, Northwestern, Chicago, Notre Dame, and Washington at St. Louis.

For the past year MURA has been supported by the AEC as by member institutions. Previously, the Office of Naval Research and the National Science Foundation have contributed to operating funds, while most staff members were on leave with salaries from their home universities.

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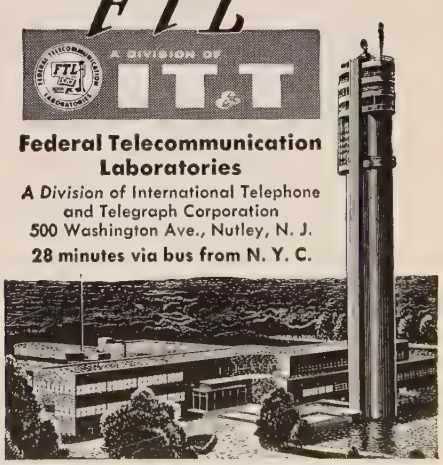

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- *new polyethylene pipe compound*
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These are some of the advances made possible by a unique new polyethylene pipe compound developed by Allied Chemical. A very high molecular weight polyethylene, it is the successful culmination of 10 years of basic research at our Central Research Laboratories. It is now in commercial production.

Development work is now underway to find other uses for the resin's exceptional physical properties, for the time when the production rate permits sale beyond pipe manufacture. Likely candidates for new uses are tubings, films, sheets, tiles, moldings and fibers.

New plastic pipe made by Orangeburg Mfg. Co.

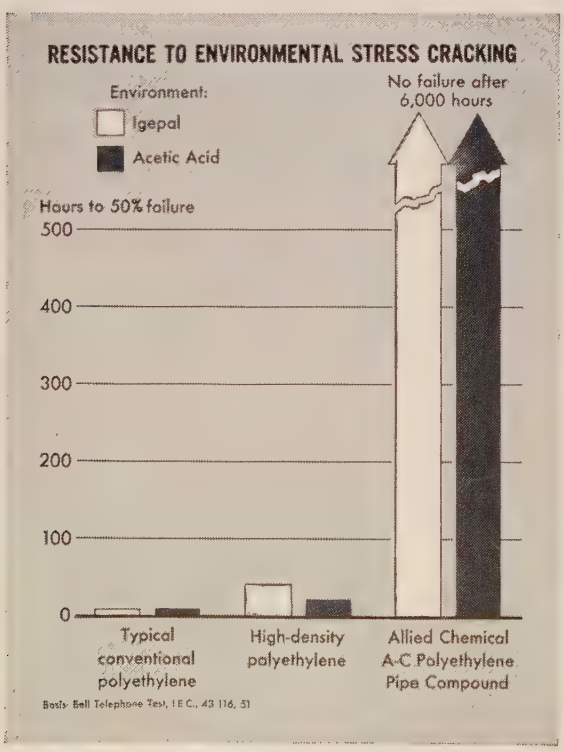
This distinctly different polyethylene resin made at low pressure is the best thing yet for extruding a superior polyethylene pipe. Pipe being made from the new A-C polyethylene pipe compound has high bursting strength, resistance to impact, shows no stress cracking, has superior heat resistance and resistance to chemicals, organic solvent and hydrocarbon liquids.

These properties are due to the high molecular weight — on the order of 750,000 — and structure of the polyethylene molecule, not present in any other known polyethylene. These new qualities will greatly expand the acceptance of plastic pipe for water service and industrial applications. A common fault of some polyethylene pipe has been environmental stress cracking; this is entirely overcome in pipe made of this new resin.

Also, tests indicate the pipe will be suitable for carrying solvents and hydrocarbons for oil and gas pipe lines, a use denied to conventional polyethylene pipe. There is a growing need in this field for a flexible, tough pipe, resistant to the corrosive conditions which attack steel pipe.

A-C polyethylene pipe compound has an unusually high melt viscosity, reflecting its great molecular weight, and requires special techniques for manufacture of pipe.

The new resin is a companion product to a line of low molecular weight polyethylene products introduced on a commercial scale in 1954 by Allied. These are used in the injection molding of many household items, and as additives in paper coatings, polishes and printing inks.



Ammonia data book

A new 68-page technical book on ammonia has been prepared by the largest ammonia producer, Allied's Nitrogen Division.

The comprehensive manual is actually a two-in-one piece: the first section on ammonia, and the second on ammonia liquor. Its contents include major uses, physical and chemical properties, specifications, shipping and storage procedures, physical tables, graphs and analytical procedures.

Major ammonia consumers — industries such as explosives, textiles, petroleum refining, refrigeration, pulp and paper, metallurgy and synthetic resin — will be interested in this up-to-date information.

Creative Research

These examples of product development work are illustrative of some of Allied Chemical's research activities and opportunities. Allied divisions offer rewarding careers in many different areas of chemical research and development.

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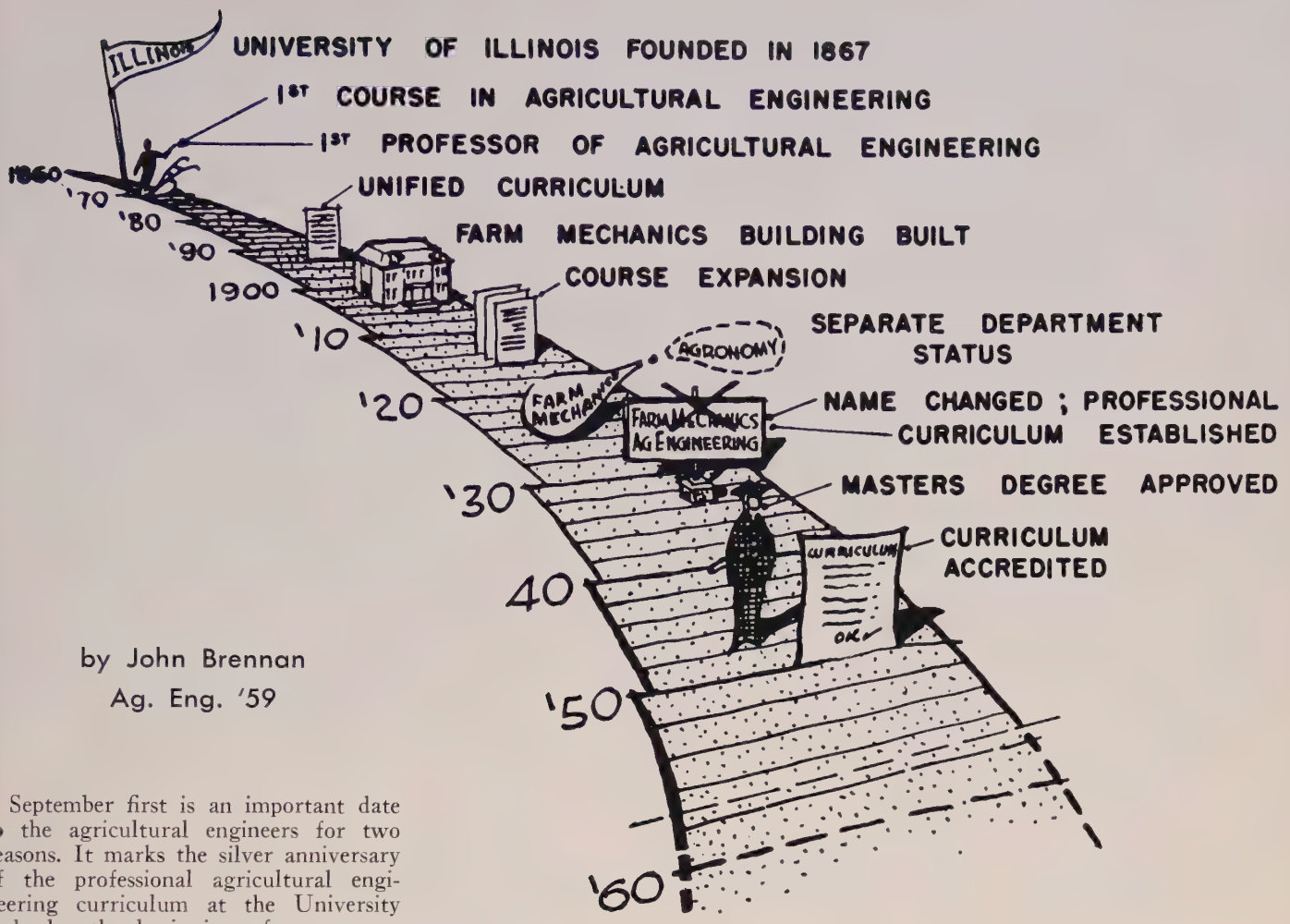

by John Brennan
Ag. Eng. '59

Silver Anniversary for Ag Engineers

September first is an important date to the agricultural engineers for two reasons. It marks the silver anniversary of the professional agricultural engineering curriculum at the University and also the beginning of a new era in the application of engineering to agriculture.

Actually, agricultural engineering is about as old as the University itself. In 1868, one year after the University of Illinois was opened, a course entitled "Rural Engineering and Architecture" was offered by the Department of Agriculture. This course included farm buildings, surveying and mapping, fences, farm implements, and road building.

Col. S. W. Shattuck was appointed Professor of Agricultural Engineering, starting with the 1870-71 school term. Records reveal that the University of Illinois was probably the first school to have an agricultural engineering professor. Under the direction of Professor Shattuck, several courses in drainage, agricultural drawing, and domestic agriculture were established.

In 1900, Agricultural Engineering was assigned to the Agronomy Department as the Department of Farm Mechanics with Professor F. R. Crane as department head. Five courses were now being offered. Upon completion of the Farm Mechanics building in 1906, the Department moved from 600 Davenport Hall to its present location on south campus. The period from 1906 to 1921 was one of great expansion.

In 1921, Professor E. W. Lehman was appointed head of the reorganized and now separate department, which came to be known as the Department of Agricultural Engineering in 1932 when the professional curriculum was established. The curriculum was subsequently accepted in 1950 by the Engineer's Council for Professional Development.

In September of 1956, Dr. F. B. Lanham took the post, which he presently holds, as the second head of the Department of Agricultural Engineering.

The Department is not without its humorous history either. Old timers still wonder who ignited the load of hay while demonstrating the merits of hay drying. And there was the department blacksmith who seemed to think that a lap weld held tighter when he used colorful language for flux.

The Department of Agricultural Engineering has contributed much to Illinois Agriculture as well as to that of the nation. Agricultural Engineers of the University of Illinois have led the way in the development of the corn picker-sheller, feed processing and handling equipment, self-unloading structures, farm housing, farm sanitation, farm electrification and better harvesting methods. However, of even greater importance is the new era which is now starting and whose advances appear almost daily in the newspapers.

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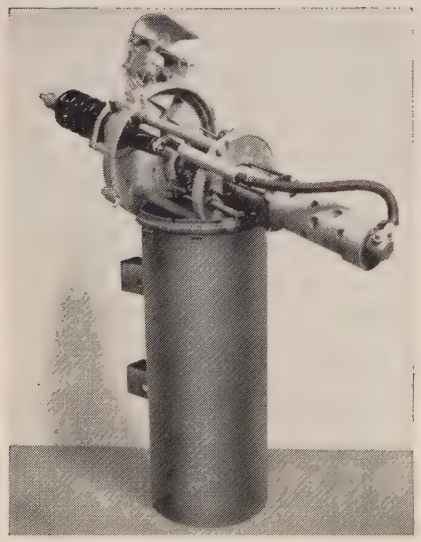

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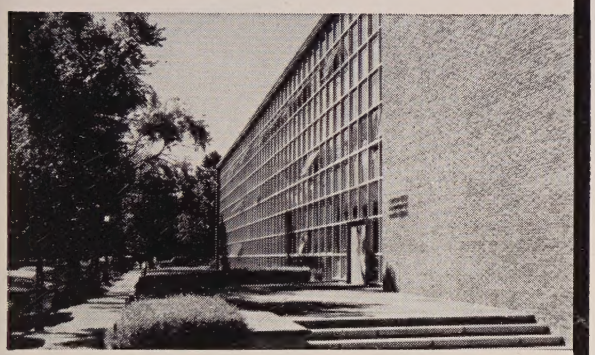

HARVARD

M. I. T.

FOR STUDY AT CALTECH, HARVARD AND M.I.T. IN 1958-59

The Raytheon Graduate Program has been established to contribute to the technical development of scientists and engineers at Raytheon. It provides the opportunity to selected persons employed by Raytheon, who are accepted as graduate students by Harvard, M.I.T. or California Institute of Technology to pursue, at Raytheon's expense, regular courses of study leading to a master's degree in science or engineering in the institution of their choice.

The Program requires, in general, two or three semesters of study, depending on circumstances, with the summer months spent in the Company's research, engineering, or manufacturing divisions. It includes full tuition, fees, book allowances and a salary while at school. Students also receive health, accident, retirement and life insurance benefits, annual vacation and other privileges of full-time Raytheon employees.

To be considered for the Program, applicants must have a bachelor's degree in science or engineering, and should have outstanding student records, show technical promise, and possess mature personal characteristics. They must be under 30 years of age on September 15 of the year admitted to the Program. They may apply for admission to the Program in anticipation of becoming employees of Raytheon.

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Gases

The direct conversion of the chemical energy of gases into electricity—long a dream of scientists and for years a laboratory curiosity—has been accomplished here with the development of the first fuel cell capable of economically producing thousands of watts of power. Using hydrogen and oxygen as fuel, the new silent source of power has been developed by scientists at the Research Laboratories of National Carbon.

First significant application of the new fuel cells is in providing silent electrical power for the U. S. Army Signal Corp's new "Silent Sentry," which is being demonstrated this week at the Association of the U. S. Army's Communications and Electronics Symposium in Arizona. The world's smallest known radar set, the lightweight, portable unit provides mobile Army forces with local combat surveillance of enemy movements despite smoke, darkness, or fog. A battery of fuel cells provides power to operate the radar set at the U. S. Army Electronic Proving Ground at Fort Huachuca, Arizona. Leading communications and electronics authorities from both military and industrial organizations are attending the three-day technical meeting.

"Secret of the new fuel cell's success," Dr. C. E. Larson, NC's research vice president, said, "is the chemically treated, hollow, porous carbon electrodes through which the gases enter the cell and which also conduct the electricity produced by the electrochemical reaction."

Designed to work at ambient temperatures, and at approximately atmospheric pressure, the new fuel cell is the first that does not depend on high temperatures or pressures for efficient operation, Dr. Larson explained.

The production of electricity directly from hydrogen and oxygen in a fuel cell is inherently more efficient than its production in a conventional steam system in which the heat is supplied by burning these same gases. Practical limitations in utilizing all of the heat produced reduce the overall efficiency of a steam system to approximately 30 or 35 per cent, while a fuel cell, which eliminates the intermediate heat step and converts directly from chemical to electrical energy, has a top efficiency of about twice that figure.

"Unlike conventional batteries, fuel cells remain essentially unchanged during their operating life and produce electrical energy from chemical fuels

Hydrogen and oxygen can now be converted into electrical energy as demonstrated by U. S. Army's new 'Silent Sentry,' world's smallest radar set

Yield Electricity

supplied as needed," said Dr. Karl Kordesch, who has been responsible for the research work. "A primary battery, such as used in a flashlight, produces electrical energy by the consumption of its chemical elements. When the chemicals are used up, the battery is 'dead.' A secondary battery, such as used in an automobile, can be recharged during its life by passing electricity back into it where it is stored for future use.

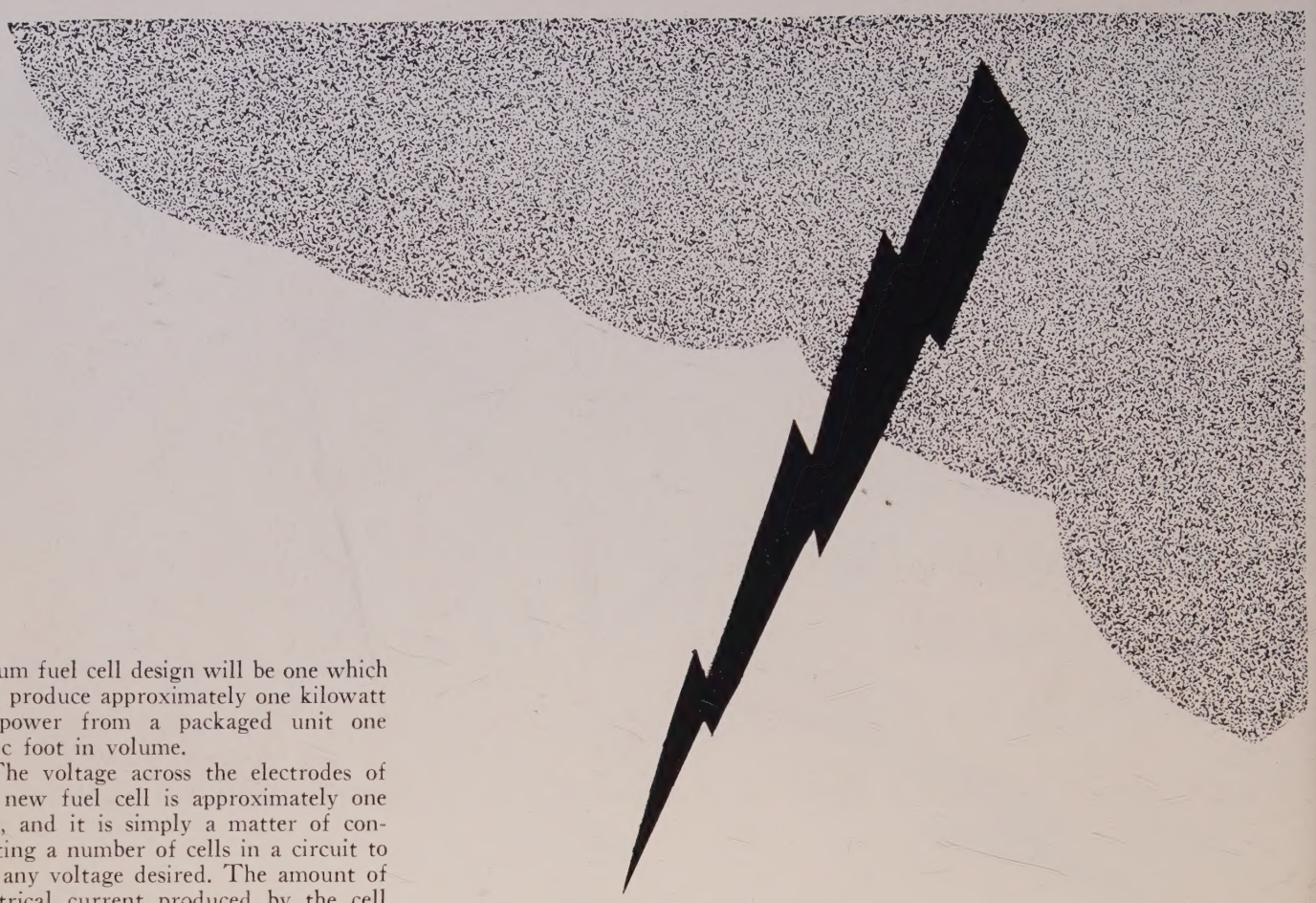
"This new fuel cell," Dr. Kordesch explained, "is merely a sealed jar into which are fed hydrogen and oxygen through the special hollow electrodes. The electrochemical reaction of the gases at these electrodes produces an electric current, with only water as a by-product. With the water disposed of by evaporation, the life of the fuel cell is theoretically unlimited. Cells have been operating here at Parma 8 hours a day, 5 days a week for the past year, with no signs of deterioration. This type of operation was purposely chosen for testing because the repeated starts and stops are much harder on the cell than would be continuous, around-the-clock operation.

No power plant is 100 per cent efficient, Dr. Kordesch went on, and some of the energy produced is wasted as heat. Operation of the new fuel cell at ambient temperatures results in high efficiency. The new cell's normal operating temperature ranges from 120 to 140 degrees Fahrenheit.

Ability of the new fuel cell to operate at approximately atmospheric pressure has the obvious advantage of eliminating heavy, costly pressure vessels. If increased output is desired, however, it can be obtained by increasing the pressure. For a given cell, higher outputs vary directly with pressure.

One Kilowatt Per Cubic Foot

"The efficiency of operation of the new fuel cell depends on how it is used, but the general efficiency range is from 65 to 80 per cent when operated at normal temperatures and pressures," Dr. Kordesch said. "Just as an automobile gives better mileage at moderate speeds than when it is 'gunned,' so does a fuel cell operate most efficiently when no attempt is made to draw the maximum power from a minimum volume. Efficiency is affected by power density—that is, at lower currents, a greater percentage of the chemical energy is converted to electrical energy. Research and development to date indicate that the op-



timum fuel cell design will be one which will produce approximately one kilowatt of power from a packaged unit one cubic foot in volume.

The voltage across the electrodes of the new fuel cell is approximately one volt, and it is simply a matter of connecting a number of cells in a circuit to get any voltage desired. The amount of electrical current produced by the cell depends on its physical size, so by varying the number or size of cells, many combinations of voltages and currents can be obtained. Basically, the fuel cell is most desirable for high current, low voltage use.

Operation on Air Possible

Although pure oxygen is required for higher current densities, the new fuel cell can be operated with hydrogen and air for producing smaller amounts of power. This is particularly advantageous for small, mobile units which can be operated simply on a tank of hydrogen and the surrounding air.

The new design is also unique in that the cell can operate with hydrogen containing considerable impurities, which means that standard industrial grades of commercial purity can be used.

Cell Construction and Operation

Present designs call for the grouping of a number of specially catalyzed, hollow porous carbon electrodes in a sealed cell containing a solution of potassium hydroxide as the electrolyte. Hydrogen and oxygen enter the cell through the hollow electrodes and diffuse through the porous carbon to the surface, where they come in contact with the electrolyte. At the hydrogen electrode, the electrochemical reaction with the potassium hydroxide produces water and releases an electron that enters the electrical circuit. The electron flows through the external circuit and returns to the cell at the oxygen electrode, where in the electrochemical reaction of the oxygen and the electrolyte, the electron is accepted. Ionic conductivity through the electrolyte completes the electrical circuit.

A concentric tube design has also been developed in which one electrode tube nestles within the other, with the electrolyte in between. The tubes are simply made long enough to give the proper cell volume for the current desired.

Fuel Cell's Future

The inherent advantages of the fuel cell make it an ideal source of silent electrical power in remote locations where conventional fuels or water power are not available. Military communications systems, mobile power units, and stand-by power plants are but a few of the expected applications.

As a producer of electrical energy, the fuel cell depends on a practical and economical source of hydrogen, a gas that at present is quite expensive and requires relatively bulky pressure vessels. Possible hydrogen sources include coal, which yields hydrogen when exposed to steam in the water gas reaction. Ammonia is another possible source, and the catalytic cracking of petroleum products can also produce hydrogen. An inexpensive source of hydrogen is a must if the fuel cell is to compete with conventional power systems as they are known today.

Another possible future use of the fuel cell is in connection with the utilization of both solar and nuclear energy. One of the problems in harnessing the energy of the sun is the storage of power. During sunny periods, the energy of the sun could be used to decompose water into hydrogen and oxygen for later use in fuel cells. Nuclear energy is known to decompose water, and in present nuclear plants in which the reactor serves only as a source of heat in the conventional steam cycle, efforts have to be made to prevent this decomposition. Perhaps it will work the other way, with nuclear energy directly producing hydrogen and oxygen for fuel cell operation.

"The demand for portable and remote silent sources of power has increased rapidly in the last few years," Dr. Larson concluded, "and countless uses await a practical solution to the problem. The fuel cell holds great promise for the future, and the day may well come when such common devices as lawnmowers, outboard motors, and even small cars will silently be propelled by the power output of fuel cells. Gone will be the noisy put-put of the combustion engine, for fuel cells will be using the same fuel to convert directly to electrical energy for powering quiet motors."